STATE OF THE ENVIRONMENT

Report for Manitoba

- *Conditions and Trends*
- *Facts and Figures*
- *Problems and Solutions*

1991

Manitoba
Environment

ABOUT THE FIRST EDITION

The State of the Environment Report for Manitoba –1991 had its beginnings in 1988 when Manitoba's Environment Act came into effect.

The Act provided that "The Minister shall cause to be prepared a State of the Environment Report within three years from the date of coming into force of this Act and at least every two years thereafter containing the following information: (a) description of Manitoba's environmental quality and activities related to present environmental issues, and (b) future environmental issues, projected trends, and environmental management activities."

Problems Versus Inventory

In attempting to fulfil the terms of reference of the report, we have focused on problems that affect the environment and what is being done to solve them, rather than on an inventory of our environmental resources.

We felt that readers would gain a better idea of the province's environment and the shape it is in through insights on the pressures of agriculture, forestry, and other human activities that alter the state of the environment. Statistics on numbers of sheep and hogs or blades of grass were warranted only when they helped define those pressures.

We have also mentioned a range of techniques and strategies for environmental protection to give readers a fuller appreciation of environmental issues and how they are tackled. But this is not a how-to book. For nuts-and-bolts ideas on environmental conservation and preservation, please consult the references listed in **Selected Reading** at the back of the report.

Data and Deadlines

The 1986 Canada Census, our last major census, was a primary source of data for the report, supplemented wherever possible by more recent information drawn from departmental files.

The deadline for major corrections and additions was set at September 30, 1990, to avoid jeopardizing the publishing deadline of March 31, 1991. To make the report as complete and timely as possible, we continued to make spot revisions until the end of January 1991, based on suggestions from nearly 50 reviewers in the public and private sectors, inside and outside the province. The write-up on Rafferty-Alameda in **Stories From the Files,** the last piece of copy to be added, was drafted in the first week of February.

SOE Reporting in Canada

Manitoba is the first province to legislate SOE reporting, although it is not the first province to prepare an SOE report. In 1985, Environment Canada released an SOE report on Atlantic Canada, and in 1986 it issued the first national SOE report. In 1988, Quebec released a two-part document highlighting the state of its environment. The document proved so successful that Quebec has made SOE reporting a regular process. Most of the other provinces are preparing to produce their own reports.

Focus Issue

In a departure from most SOE documents, we have included a section entitled **Focus Issue–Waste Management.** A kind of cover story, focus issues warrant separate treatment from familiar topics such as water, air, and wildlife that will always have a place in an SOE report. Subsequent editions will feature different focus issues that analyse and interpret a critical and timely subject.

Trends

Each major section of the report concludes with a handful of trends rated WORSE, SAME, or BETTER.

Based on the collective thinking of the editors and on consultation with government specialists, the trends evaluate progress in the 1980s and lay the groundwork for measuring how well we are doing, in subsequent reports. The trends are expected to generate considerable interest and discussion about the state of the environment.

Concerned Manitobans

The report is aimed at Manitobans who are concerned about the province's environment, which takes in a very large audience judging from the results of numerous polls showing that most of us rank the environment at or near the top of our list of concerns. We hope that concerned readers in the scientific and technical communities find the report of value as an overview of environmental conflicts and resolutions in a range of disciplines.

Sustainable Development Stressed

Sustainable development – development today with an eye to the environment and the needs of future generations– is a recurring theme throughout the report. It is also discussed in a separate section that sheds further light on this important concept. In adopting sustainable development as a guiding principle, the province may well have taken its single most important step toward keeping our environment in good shape while developing our economy.

Your Feedback Invaluable

Reporting on the state of the environment for an entire province is an ambitious undertaking – particularly in the first edition of the report. Lack of proven guidelines on SOE reporting, which is still in an evolutionary stage, added a further complication. In subsequent editions, we may focus on updating the report in its present form, or take a different approach to better convey the state of the province's environment. Much of it depends on public feedback.

To that end, no contribution is of greater value than your reactions to the contents of this edition, as well as your comments and suggestions for improvement.

We would like to hear from you! Please write to us at the address on the back cover.

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REPORT OVERVIEW

The State of the Environment Report for Manitoba 1991 looks at the province's environment from two sides, the natural environment and the socioeconomic environment, and in 16 categories, from air, water, and forests to education, sustainable development, and waste management. Conditions and trends, facts and figures, and problems and solutions in each of the 16 categories are highlighted in the paragraphs below to give an overview of the state of our environment.

In virtually all categories, public interest in conserving and protecting the environment proved to be on the increase. People everywhere appear ready and willing to support policies for ensuring a healthy environment and are lending a hand, as members of environmental groups or on their own, to help restore the environment to health.

More than any other, this trend offers the greatest reassurance that the 90s will see a major effort to reverse deterioration of the environment, in Manitoba as well as in the rest of the world.

AIR

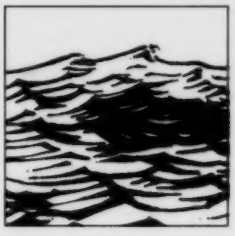
Manitoba is noted for its clean air, which is generally the result of low industrial emissions, "clean" neighbours upwind of us, and windy, dry weather that helps disperse pollutants.

In Manitoba, as in the rest of Canada, lead levels in air are well within 24-hour guidelines and continue to decline following the introduction of unleaded gasoline and the phasing out of leaded gasoline.

Levels of sulphur dioxide, one of the primary pollutants of the day, are down in Winnipeg and Brandon, and generally fall within acceptable levels around smelters in Flin Flon and Thompson. Annual emissions from the smelters are set to be reduced from 500,000 to 440,000 tonnes by January 1994. The reduction is part of the province's commitment to help combat acid rain in eastern Canada.

Last year, the province passed The Ozone Depleting Substances Act which allows us to limit the use of CFCs and ban the use of halons. CFCs and halons are major culprits in the destruction of the ozone layer.

WATER



Manitoba has plenty of surface water and groundwater, but supplies are generally concentrated in the central and northern parts of the province, far from the southerly basins where we have about 90% of our population and most of our agricultural land. Impacts on the quality and quantity of our surface water and groundwater are caused by soil erosion, the release of herbicides and other agricultural chemicals, and effluent from industrial operations. Urban and recreational developments demand water for consumption and waste assimilation, and flooding for hydroelectric works causes mercury contamination in northern waters.

Outside influences involving transboundary waters include the proposed Rafferty-Alameda dam project in Saskatchewan, the Garrison Diversion in North Dakota, and proposed mining and cottage developments on Shoal Lake in Ontario, the source of Winnipeg's drinking water.

Groundwater levels in much of the province are the same as they were 25 years ago, although pumping in Winnipeg has created a 30-metre draw-down cone and water levels in the Winkler Aquifer in southern Manitoba have dropped 3 metres in the last 15 years.

FORESTS

Our forests have supported a thriving forest industry since the turn of the century. Harvesters have traditionally taken less than 15% of the allowable annual cut – the amount of wood that can be harvested in a forested area each year on a sustainable basis. Assessments are currently underway leading to further sustainable utilization of our forest resources.

Harvesting has the greatest impact on our forests, but fire, insects, and disease are also major factors affecting forest ecosystems. Harvesting plans must be assessed in environmental impact statements and approved under The Environment Act, a process that includes public hearings. Harvesters are also required to ensure that areas harvested will continue to grow forests. Manitoba supports a substantial fire prevention and response effort, as well as programs to deal with pest outbreaks such as Dutch Elm Disease.

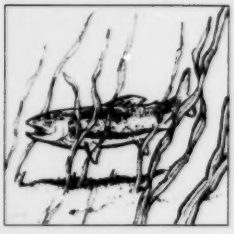
WILDLIFE

Manitoba enjoys a healthy diversity and abundance of wildlife species, but loss of habitat, mainly to development, is serious. Efforts to slow the loss include projects under the North American Waterfowl Management Plan, the Heritage Marsh Program, and the Critical Wildlife Habitat Program. The province boasts more than 150 special habitat havens ranging from wildlife management areas for managing wildlife and wildlife habitat, to special conservation areas for protecting rare or endangered species.

Although the overall loss of habitat continues at an alarming pace, wildlife managers have succeeded in bringing back some of the species we have harmed most – peregrine falcons and polar bears.

Trapping and hunting are the prime consumptive uses of wildlife. Manitobans harvest and consume roughly 2 million kilograms of wildlife annually. But viewing, photography, and other non-consumptive uses of wildlife are extensive and growing, judging from trends in the sale of natural history materials and supplies such as bird feeders.

FISH



Our lakes, rivers, and streams support more than 90 species of fish, but numbers of walleye, whitefish, and other major commercial species have generally declined in the last several decades through loss of habitat and overfishing.

Fish are vulnerable to a variety of threats, from land uses that ruin spawning sites by blanketing them with silt and clay particles, to domestic animal wastes and agricultural chemicals that promote algae blooms capable of suffocating fish by using up valuable oxygen in the water. Even other fish and shellfish can present a problem. Rainbow smelts, recent arrivals in the province, could undermine the whitefish and walleye fisheries on Lake Winnipeg.

Lower commercial fishing quotas and angler creel limits, licence buy-back programs, derby permits, conservation licences, and catch/release programs are proving successful in addressing the classic problem of fisheries management: too many fishermen chasing too few fish. Supported by the efforts of commercial and sport anglers, fish and game associations, and others who lend a hand in managing local fishery resources, they are salvaging and safeguarding many of our fisheries, key examples being the commercial fishery on Lake Winnipegosis, the sport fishery at Lac du Bonnet, and the goldeye fishery on Lake Winnipeg.

SPECIAL SPECIES

Those of our plants, animals, and fish that are rare, threatened, endangered, or extirpated qualify as special species. They number just over 70, from bald eagles, mule deer, and lake sturgeon, to the northern prairie skink, small white lady's-slipper, and trumpeter swan. How well they are faring gives some idea of the overall environmental health of the province.

They are at risk primarily because of human activity that causes pollution and destroys habitat. Protection mainly takes the form of environmental legislation such as The Endangered Species Act, The Wildlife Act, and The Ecological Reserves Act. In the long run, the greatest contribution to their well-being will come from the volunteers, landowners, and other interested and concerned people who are aware of the fragility of certain species and take an active interest in preserving them, in some cases by setting aside parcels of their own land for their protection.

SPECIAL AREAS

Our parks, ecologically significant areas, heritage rivers, and heritage resources are categorized as special areas. They range from Riding Mountain National Park to the childhood home of Margaret Laurence in Neepawa.

Aside from giving tourism a boost, these and another estimated 400 to 500 special areas across the province provide social, psychological, recreational, and educational benefits that can enrich our lives and the lives of future generations.

Manitoba was the first province in Canada to endorse the Endangered Spaces Program, an endeavour to protect 12% of the natural regions of each nation by the turn of the century, as recommended by the United Nations and the World Wildlife Fund Canada. Manitoba's commitment will become part of the Canadian national effort.

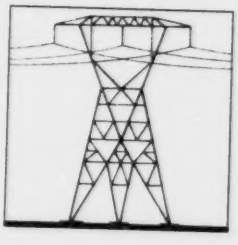
AGRICULTURE

Agriculture, the traditional mainstay of the province's economy, continues to thrive despite the loss of productive farmland to urban subdivisions and other new developments.

Farmers now use 35 times as much fertilizer as they did in the 1950s. Although continued use of fertilizers and herbicides may be necessary to keep the land productive, care must be taken to keep these products out of our streams, lakes, and rivers.

The last 2 decades have seen intense interest on the part of the province's farmers in applying techniques that put agriculture on a sustainable basis by reducing soil erosion and salinity, and boosting soil moisture. Farmers are burning less stubble, cutting the amount of acreage they summerfallow, and using minimum or zero tillage methods.

ENERGY

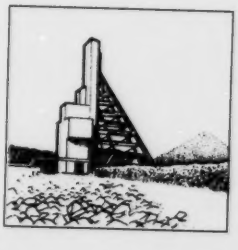


Fossil fuels, which we import, represent about three-quarters of the energy we consume. The remainder is primarily hydroelectric power which we produce, mainly at generating stations in the north. We also produce crude oil but export it since we have no oil refineries.

Although hydroelectricity is a relatively clean source of power, it carries an environmental price that was paid mainly during the 60s and 70s with construction of hydroelectric developments on the Nelson River. Impacts ranged from flooding and other environmental effects to major changes in the lifestyles and culture of Native people. The construction of generating stations and transmission lines, as well as natural gas pipelines and other energy related engineering works is subject to environmental reviews and licensing under The Environment Act.

The substitution of different forms of renewable energy, such as hydroelectricity for fossil fuels, is constrained by economic and technological factors. Electric cars, for example, still have technological and cost disadvantages compared to their gasoline-powered counterparts.

MINING



Mining carried Manitoba through the Depression and opened up the north by sparking the creation of Flin Flon, Thompson, and other northern communities where mineral resources have been prolific over the years.

Some metal mines produce sulphide tailings that can combine with runoff to form sulphuric acid which in turn dissolves heavy metals in the tailings, presenting a threat to local surface water and groundwater supplies. Non-sulphide tailings, such as those from gold mines, can carry residues of arsenic capable of harming fish and other aquatic life. Smelting of sulphide-rich ores releases large volumes of sulphur dioxide into the air, contributing to atmospheric pollution. Peat mining involves draining sites and removing vegetation, both forms of environmental damage.

Legislation addresses most of these impacts, controlling the release of effluents, sulphur dioxide, and dust. Legislation for rehabilitating pits and quarries is currently under revision. Regulations concerning acid-generating tailings are not in place, but the province addresses the closure and rehabilitation of mines that produce such tailings on a site-by-site basis.

TRANSPORTATION

Manitoba has traditionally served as a transportation crossroads for Canada, and our road, rail, and air linkages continue to play a major role in the economic development of the province – and the nation.

Noise, loss of land, noxious emissions, litter, salt and other chemicals used on highways and rights-of-way, and the depletion of fossil fuels are among the major impacts. Loss of land is perhaps the most visible impact, with more than 320,000 hectares tied up in highways and roads, railways, and major airports. Although the loss is insignificant in terms of the total area of the province, most of the land is in southern Manitoba where competition for land use is strongest.

Recycling of oil, radial tires, and even asphalt for new pavements are among the many programs that help minimize the environmental impacts of transportation. One of the most promising ways of reducing emissions, particularly those that contribute to global warming, is greater use of public transportation systems, but so far this approach shows little sign of catching on. Other measures that could prove valuable in the future include flexible working hours along with 4-day work weeks to reduce traffic tie-ups, and locating work centres in residential areas so that employees can cycle or walk to work.

POPULATION

We have a low overall population of just over one million, a natural rate of increase slightly below the national average, and a tendency, as in the rest of Canada, to depend on immigration to maintain our population levels. In light of these factors, we can reasonably expect that the environmental impacts of population will develop from concentrations of people in Winnipeg and other major population centres, rather than from massive numbers of people everywhere putting pressure on our natural resources.

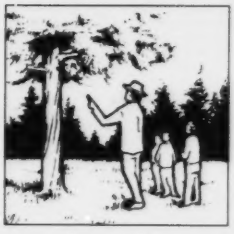
Concentrations of people in and around our cities are already causing environmental problems, from air pollution that continues to mount as people choose cars over buses, to demand for small rural acreages outside town that often take up productive land. People are also moving from north to south and from the country to the city, often to Winnipeg where 60% of Manitobans now live.

LEGISLATION

Several new acts and regulations passed in the last 15 years represent a dramatic improvement in legislation to protect our quality of life, environmental heritage, and natural resources. Key pieces of legislation in recent years include The Environment Act, The Dangerous Goods Handling and Transportation Act, The Waste Reduction and Prevention Act, and The Ozone Depleting Substances Act.

The Environment Act, one of the most important of these legislative milestones, covers the assessment of any development likely to affect the environment as well as a permitting system that specifies terms and conditions to control the development if it gains approval. The Act recognizes the importance of public participation in environmental decision-making, provides penalties for non-compliance, ranging from fines of up to $1 million to jail sentences, and requires that information on proposed projects be on file at public registries across the province.

EDUCATION



Environmental education is designed to communicate skills and attitudes that prepare people in all walks of life to support or take action to protect the environment. One of the foremost examples is Project WILD, an environmental and conservation education program that helps youngsters learn how to think, not what to think. In Manitoba's schools, the concept of sustainable development is being integrated into the curriculum across all grade levels. "Be a Friend to the Environment" is a made-in-Manitoba series of booklets focusing on recycling and waste reduction, with activities for children in kindergarten to grade 4. Our community colleges and universities are adding more environmental courses to their curricula and supporting recycling efforts on campus.

Manitoba is the setting for several world-class environmental education facilities, including Fort Whyte Centre, Delta Marsh Field Station, Sandilands Forest Centre, and the Museum of Man and Nature.

SUSTAINABLE DEVELOPMENT

The environment and the economy can no longer be viewed as separate concerns. The challenge is to develop the economy while conserving the environment.

In taking on this challenge, the province established the Manitoba Round Table on Environment and Economy, released an overall sustain ble development strategy, and launched a series of public consultation programs in 1989. To date 12 component strategies have been initiated, which will involve the public in developing and refining policies for managing all aspects of the environment and economy to ensure a sustainable future for Manitoba.

The province is not alone in taking up the challenge of sustainable development. People in Manitoba are putting the principle into action, from members of rural conservation districts who have been applying it in managing their resources since the 70s, to an entrepreneur in Winkler who recycles tires into mats, tiles, and mudguards.

FOCUS ISSUE: WASTE MANAGEMENT

Manitobans generate nearly 1,000,000 tonnes of garbage every year. Garbage takes the form of hazardous and non-hazardous waste or municipal solid waste from household, light industrial, and commercial sources. In 1989, Canada led the world with 1.7 kilograms per person per day, while Australia and the United States tied for second place at 1.6 kilograms per person per day.

A waste minimization strategy, developed in response to public demand, was launched in 1990 to reduce waste produced by the provincial government and ensure that the rest of us accept our own responsibilities for cutting waste. The strategy stresses the 4 Rs – reduce, reuse, recycle, and recover – and has set a goal of reducing by 50% the amount of waste per capita going to landfill sites by the year 2000.

The Manitoba Hazardous Waste Management Corporation, with a mandate to plan and develop a hazardous waste management system for the province, is currently investigating prospective sites for facilities to store and treat hazardous wastes, including PCBs.

Among the success stories in waste management are increases in returns of non-deposit containers for recycling, phasing out of PCBs by Manitoba Hydro, elimination of pesticide container dumps in rural areas, conversion of former landfill sites to recreation areas, and the phasing out of combined sewers that add "dirty" water directly to our rivers. But it will take an effort on several fronts, ranging from regulations and incentives to environmental education and public consultation, to succeed in dealing with this problem of our own making.

NATURAL REGIONS

Five natural regions are discussed in this report to provide a framework for describing the state of Manitoba's environment. They are the Northern Transition/Tundra, Northern Coniferous Forest, Broadleaf/Mixedwood Forest, Grassland, and Winnipeg. Each region is distinct from the others in its geology, terrain, water, vegetation, wildlife, climate, and human activities.

Northern Transition/Tundra

Covering the northern part of Manitoba, this region is marked by an arctic to subarctic climate with total annual precipitation ranging from less than 300 millimetres to 350 millimetres. Summers are cool and short while winters are long and bitterly cold. Mean annual temperature is -5°C to -7°C.

Soils are poorly developed and vegetation sparse. Lichen, mosses, and rock cranberry are common ground cover species. Black spruce and willow grow in sheltered areas. Eskers, moraines, palsas, and ice polygons are dominant features of the landscape. Bedrock formations are principally limestone, shale, and granite.

This wind-scoured landscape is home in the brief summer to hundreds of bird species, in particular, shorebirds and waterfowl along the Hudson Bay coast. The world's largest concentration of polar bears is found along the coastline.

Major industries are trapping, tourism, and hydroelectric power. The subarctic seaport of Churchill, a major grain terminal, is ice-free from mid June to early November.

Northern Coniferous Forest

Largest of the five regions, the Northern Coniferous Forest covers a broad band across the central part of the province and extending down the east side of Lake Winnipeg.

The climate is boreal: summers are short and cool, and winters are long and cold, with persistent, deep snow cover. Mean annual temperature ranges from 2°C in the south to -4°C in the north. Annual precipitation varies from 300 to 500 millimetres.

Precambrian shield formations underlie most of the area, with rock formations largely controlling drainage. Rock outcroppings are common in the northwest corner and on the east side. There are numerous moraines and eskers from glaciation. Many wetlands such as bogs, fens, swamps, and marshes occur in this region. The dominant tree species are spruce, jack pine, poplar, and birch. Common wildlife includes moose, black bear, beaver, and spruce grouse.

Most people make their living by hunting, trapping, fishing, lumbering, or mining. Resource industry cities, towns, and communities such as The Pas, Flin Flon, Thompson, and Lynn Lake are located here.

Northern Coniferous Forest

Northern Transition/Tundra

Grassland

Broadleaf/Mixedwood Forest

Winnipeg

Broadleaf/Mixedwood Forest

This region lies in the southcentral portion of the province, extending from the Saskatchewan border through the Interlake to the west edge of Lake Winnipeg. It, too, has a boreal climate.

Geologically, the area is composed largely of limestone and shale overlain by deposits of silt and clay from glacial Lake Agassiz. Tree species include spruce, aspen, elm, oak, and maple. White-tailed deer, black bear, as well as ruffed and sharp-tailed grouse are common.

Along the western border of the region lie three upland areas that form part of the Manitoba Escarpment. To the south is Riding Mountain National Park, well known for its herds of elk and its display herd of bison. To the north are Duck Mountain Provincial Park and the Porcupine Mountains which have fairly large concentrations of moose.

Forestry, mixed farming, and tourism are major industries.

Grassland

This prairie region covers the area in the southwest part of the province, extending just east of Winnipeg. Summers are sunny and warm, with occasional intrusions of humid, tropical air. Winters are cold compared to other parts of southern Canada. Wind is a constant feature of the open grasslands. It causes spring dust storms and makes for bitter winter days. Annual precipitation ranges from 550 millimetres in the east to about 450 millimetres in the west. Mean annual temperature is 2°C.

Formations of sandstone and shale are overlain with heavy clay and silt deposits left by meltwater from the glaciers. Old beach ridges and moraines are part of the landscape. The flat terrain is broken by river valleys and several upland areas such as the Turtle Mountains and the Brandon and Tiger hills which form part of the Manitoba Escarpment.

Aspen and willow stands dominate these areas and shelter wildlife such as white-tailed deer and sharp-tailed grouse. In spring, numerous temporary ponds or "potholes" offer breeding habitat to thousands of ducks.

The area is largely agricultural and is a principal producer of cereal crops. Brandon and other major urban centres are located in this region.

Winnipeg

Winnipeg is recognized as a unique region since the city exerts a significant influence on the state of the environment in Manitoba. It is in the grassland climatic zone and has a continental climate. Normal mean temperatures range from -20°C in mid January to 20°C in mid July. Precipitation averages 525 millimetres over the year; average winter snowfall is about 125 centimetres. Thunderstorm activity is at a maximum in July; hail is infrequent.

Winnipeg has a population of about 600,000 – more than half the residents of the province. The city has grown into a major centre from its original roots as an Indian meeting place and fur trading post at the junction of the Red and Assiniboine rivers.

Recent developments in the city have concentrated on restoring its river banks to their early prominence, particularly in The Forks area, a national historic site. The city boasts a large white-tailed deer population spread over its many parks and green areas.

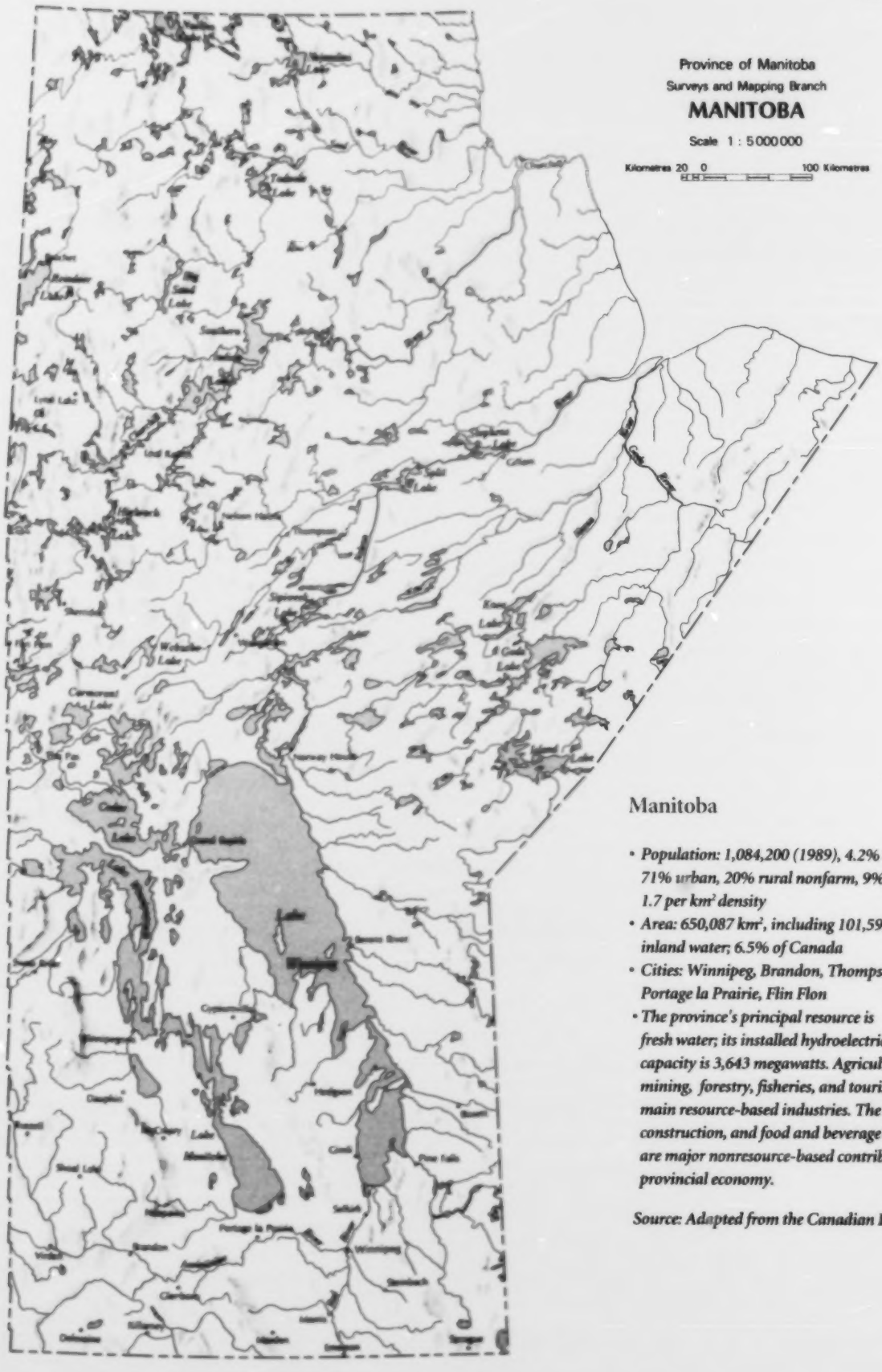
Provincial Profile

Manitoba embraces eleven degrees of latitude, extending 1,300 kilometres from north to south. The landscape varies from prairie grassland in the south, through broadleaf, mixedwood, and boreal forests, to tundra along the shoreline of Hudson Bay.

The northern half of Manitoba is a watery maze of lakes, rivers, and streams, a legacy of glacial action. In the lowlands of central Manitoba three large lakes – Winnipeg, Manitoba, and Winnipegosis – hold what remains of glacial Lake Agassiz, an immense prehistoric lake that once covered nearly five-sixths of the province. Lake Winnipeg, with a length of 400 kilometres and an area of 35,000 square kilometres, is the largest of our lakes and the 13th largest in the world.

Four major rivers drain the northern reaches of the province and empty into Hudson Bay: the Churchill, the Nelson, the Seal, and the Hayes. In the south, the Red and Assiniboine meander through the grasslands to Lake Winnipeg.

Manitoba's original inhabitants included the Cree, Chippewyan, and Saulteaux. The province got its name from Manitou, the Cree word for the Great Spirit. Europeans came through in the 1700s in search of furs and the Northwest Passage. The first settlers were Scottish and French, followed by a westward tide of English settlers from Ontario, French-speaking settlers from Quebec, and later by Icelanders, Mennonites from Russia, and substantial migrations from Great Britain, Europe, and the Philippines.



Manitoba

- *Population: 1,084,200 (1989), 4.2% of Canada; 71% urban, 20% rural nonfarm, 9% farm; 1.7 per km² density*
- *Area: 650,087 km², including 101,592 km² of inland water; 6.5% of Canada*
- *Cities: Winnipeg, Brandon, Thompson, Portage la Prairie, Flin Flon*
- *The province's principal resource is fresh water; its installed hydroelectric generating capacity is 3,643 megawatts. Agriculture, mining, forestry, fisheries, and tourism are the main resource-based industries. The services, construction, and food and beverage industries are major nonresource-based contributors to provincial economy.*

Source: Adapted from the Canadian Encyclopedia

AIR

Manitoba is noted for its blue skies and clean air. Winnipeg, with a population of more than 600,000, ranks among the top larger urban centres in Canada for its good air quality.

Low industrial emissions and windy, dry weather help disperse pollutants. On occasion, however, a specific event or industrial emission can degrade air quality – dust storms, forest fires, elevated sulphur dioxide levels near northern smelters, or odours from rendering industries. Most of these types of problems can be resolved by licensing and enforcement.

An air quality index has been developed for Manitoba and is expected to be implemented in the 1990s. The index expresses levels of several key air pollutants to provide the public with a general idea of the quality of air in the community. Daily air quality indexes are currently in use in parts of Ontario, Alberta, British Columbia, Quebec, and New Brunswick.

Monitoring

Pollutants in the atmosphere can threaten human health, inhibit vegetation growth, damage materials, react to form acid rain and other destructive substances, and diffuse into the atmosphere causing impacts many kilometres from the original source.

Since 1970, the province has monitored selected pollutants at several locations. Monitoring instruments are usually installed at sites where air pollution could present a problem and large numbers of people could be affected. These sites are referred to as "monitoring stations."

Urban monitoring is generally performed in cooperation with the federal government's National Air Pollution Surveillance program – a nationwide network for determining the quality of air in Canada. The program also documents trends in air quality affected by industrial activity, fuel use, population density, and pollution controls. Manitoba collects industry-specific data from provincially run monitoring stations in Brandon, Thompson, and Flin Flon.

Air monitoring station in Flin Flon

Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless, highly poisonous gas produced in the burning of carbonaceous materials. At high levels, it can impair perception and thinking, slow reflexes, and cause unconsciousness and death. If inhaled by pregnant women, it can threaten the growth and mental development of the fetus.

Carbon monoxide is measured at two sites in Winnipeg: downtown and residential. In 1987, all readings were below maximum acceptable levels, based on 1-hour and 8-hour intervals. From 1974 to 1987, ambient levels of CO declined in the city, possibly because of more efficient combustion processes and the use of catalytic converters on automobiles.

An estimated 750,000 tonnes of CO are discharged from all sources each year. Forest fires and vehicles are the primary sources, each emitting about 300,000 tonnes.

Sulphur Dioxide (SO_2)

Sulphur dioxide, a pungent, colourless gas formed by the burning of sulphur compounds, creates acid rain and haze, and damages vegetation. It can raise the incidence of coughs and colds, asthma, bronchitis, emphysema, and other respiratory diseases. It has also been implicated in nonrespiratory illnesses like skin allergies and reproductive problems.

Sulphur dioxide was measured at six sites in 1987: two in Winnipeg (downtown/residential), one in Brandon, two in Flin Flon, and one in Thompson. Ambient levels in Winnipeg and Brandon were well below maximum desirable levels, in keeping with a trend in both cities for many years.

Average yearly levels of SO_2 in Flin Flon and Thompson generally fall within acceptable limits. In 1990, however, levels of SO_2 in Flin Flon exceeded the 1-hour maximum acceptable level for 249 hours on 85 days spread fairly evenly over the year. There has been no problems with levels of SO_2 in Thompson. A major zinc-copper smelter is in downtown Flin Flon and a major nickel-copper smelter sits 3 kilometres south of Thompson.

Total emissions of SO_2 in the province are an estimated 555,000 tonnes each year, mainly from the two smelters (540,000 tonnes). Coal-fired thermal generators and pulp and paper mills release 7,000 tonnes, and fuel combustion by the industrial sector accounts for nearly 2,000 tonnes.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide is formed in high-temperature combustion processes. It contributes to haze, health problems, and acid rain formation.

Nitrogen dioxide is measured at two sites in Winnipeg (downtown/residential) and one in Brandon. Values recorded at all three sites in 1987 were below maximum desirable levels, in keeping with long term trends. There has been no changes in the levels of NO_2 since the mid 70s when Manitoba Environment started monitoring.

Each year, an estimated 100,000 tonnes of NO_2 are discharged from all sources, mainly in emissions from trucks, cars, diesel locomotives, and off-road vehicles. Thermal power generators contribute about 2,500 tonnes.

Selected Manitoba Air Quality Objectives

Pollutant	Concentration Unit	Measurement Time	Maximum Tolerable Level	Maximum Acceptable Level	Maximum Desirable Level
Carbon Monoxide	Parts per million	1-hour		30.000	13.000
		8-hour	17.00	13.000	5.000
Lead	Micrograms per cubic metre	24-hour		5.000	
Nitrogen Dioxide	Parts per million	1-hour	0.53	0.213	
		24-hour		0.106	
		Annual Mean		0.053	0.032
Ozone	Parts per million	1-hour	0.20	0.080	0.050
Sulphur Dioxide	Parts per million	1-hour		0.340	
		24-hour	0.31	0.110	
		Annual Mean		0.020	
Total Suspended Particulate	Micrograms per cubic metre	24-hour	400.00	120.000	
		Annual Mean		70.000	60.000

*NOTE: Objectives are based on provincial guidelines and federal limits adopted by the province. **Maximum Tolerable Levels:** When concentrations of pollutants rise above these levels, appropriate action is required to protect the health of the general population. **Maximum Acceptable Levels:** As long as concentrations of pollutants do not exceed these levels, soils, water, vegetation, animals, and people are adequately protected. **Maximum Desirable Levels:** These are long-term goals for air quality to protect unpolluted parts of the province.*
Source: Manitoba Environment

Ozone (O_3)

Ozone is a form of oxygen produced naturally and when hydrocarbons from vehicle engine exhausts and industrial processes react with nitrogen oxides in the presence of sunlight. At ground level it is a serious air pollutant that can damage crops and cause irritation of the eyes and the mucous membranes, reduce resistance to disease, and aggravate asthma and other respiratory ailments. In the upper atmosphere, it acts as a protective layer which shields us from the sun's damaging ultraviolet rays.

Ground level ozone is measured at two sites in Winnipeg and one in Brandon. The 1-hour maximum acceptable limit for ozone has been exceeded on several occasions at both the downtown Winnipeg and Brandon sites. From the mid 1970s when monitoring started, until 1987, annual mean ozone levels recorded in Brandon were higher than those in Winnipeg. Higher background levels of ozone are thought to account for this difference, since there are no industrial sources in Brandon or long-distance transport of ozone into the area.

Particulates

Particulates are solid and liquid particles that remain suspended in air. In sufficient quantities they reduce visibility and can cause severe health problems by embedding themselves in the most sensitive parts of the lungs.

Particulates are monitored at three sites in Winnipeg, two sites in Brandon, and a rural background site in St. Francois Xavier, a small town 7 kilometres outside Winnipeg. Trends from 1970 to 1987 indicate that annual concentrations of particulates have remained fairly constant.

From 1985 to 1989, the downtown Winnipeg monitoring station recorded between 28 and 38 instances when the 24-hours maximum acceptable limits for particulates were exceeded, compared to 5 to 25 instances between 1982 and 1984. In Winnipeg, elevated levels are generally recorded in spring, when traffic stirs up dust from sand that was spread on the streets in winter. Windblown dust from farm-lands is another factor in elevated dust levels.

In Manitoba, forest fires are the principal sources of particulates, emitting 280,000 of the 290,000 tonnes released in a typical year. Grain processing plants, nonferrous smelters, and pulp and paper mills release nearly 10,000 tonnes.

Lead (Pb)

Lead can affect the circulatory, reproductive, and nervous systems and may impair learning in children.

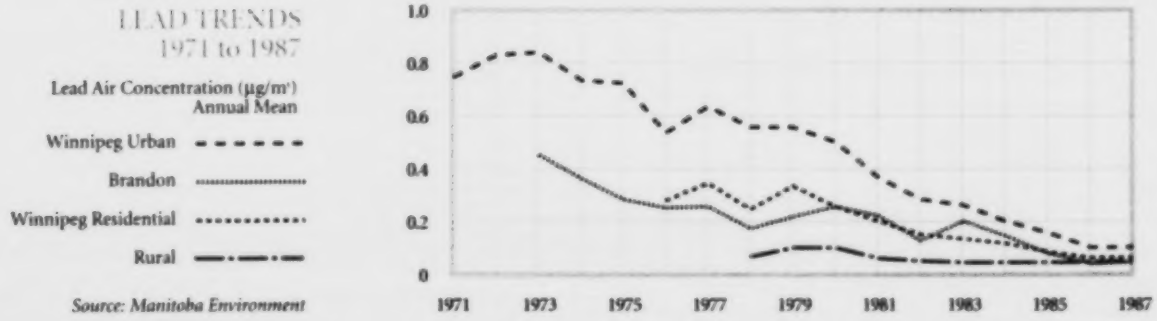
Lead levels are monitored at three sites in Winnipeg, and one each in Brandon and St. Francois Xavier. In 1987, lead levels at all sites registered well below the established 24-hour guideline. With the introduction of unleaded gasoline in 1974 and phasing out of leaded gasoline, annual mean lead concentrations in air have continued to decline.

Manitoba was one of the first jurisdictions to apply a preferential tax on leaded gasoline to encourage motorists to switch to unleaded. Federal legislation banned the sale of leaded gasoline as of December 1, 1990.

Nonferrous smelters emit an estimated 160 tonnes of lead each year. Emissions from motor vehicles release 120 tonnes.

TOTAL SUSPENDED PARTICULATES
1971 to 1987

LEAD TRENDS
1971 to 1987



Source: Manitoba Environment

Peatland fire

Smoke

Sources of smoke in the air include forest fires, stubble burning, and burning of peatlands to develop land for farming.

Problems of smoke in the air are being addressed on several fronts. In 1989, the province passed a peat smoke control regulation to reduce the amount of smoke and gases in the air we breathe and limit instances of smoke causing poor visibility along highways.

Because of excessive smoke from stubble burning in 1987 and 1989, Manitoba Environment tested for particulates, hydrocarbons, and volatile organic compounds and found that levels were below provincial air quality objectives in both years. Smoke episodes in 1989, however, were not as severe as those in 1987 because of lower straw yields, less burning, and favourable meteorological conditions for dispensing smoke.

Education and information programs encourage farmers to mulch and bury instead of burning stubble. Farmers can phone Environment Canada for information on the best times to burn.

Manitoba Regulation MR 208/76 restricts open burning at waste disposal grounds. At Class 1 sites (serving populations of more than 5,000), open burning is prohibited unless otherwise approved. Exemptions are granted only for burning clean wood or brush. At Class 2 and 3 sites (serving populations of less than 5,000 people), open burning is allowed, with the exception of rubber tires, but materials must be burned in a trench or berm.

Indoor Air Quality

Studies show that people spend 80% to 90% of their time indoors, where the air can be more seriously polluted than outdoors. As a result, most people probably face a greater risk from exposure to air pollution indoors than outdoors.

Major Indoor Air Pollutants

Here are the key indoor air pollutants and their sources:

Asbestos - deteriorating or damaged materials that contain asbestos (some types of insulation, fireproofing acoustic materials, and floor coverings)

Biological Agents (fungi, bacteria, viruses) - wet or damp ceilings, walls, carpets, and furniture; poorly maintained humidifiers, dehumidifiers, and air conditioners; bedding, pets

Carbon Monoxide - unvented kerosene and gas heaters, backdrafting furnaces, wood stoves and fireplaces, gas stoves and ovens, engine exhaust from attached garages, tobacco smoke

Formaldehyde - pressed wood products, glues, textiles, urea formaldehyde foam insulation, tobacco smoke

Lead - engine exhaust, stripping lead-based paint, use of lead solder

Nitrogen Oxides - similar to carbon monoxide

Ozone - electrical appliances, improperly installed electronic air cleaners, photocopiers

Particulates - fireplaces, wood stoves, kerosene heaters, pets, humans, tobacco smoke, house dust

Pesticides - products used to kill household pests, lawn and garden products that drift or are tracked indoors

Radon - natural breakdown of radium in the ground

Volatile Organic Compounds - paints, paint strippers and other solvents, aerosol sprays, cleaners and disinfectants, wood preservatives, moth repellents, stored fuel and vehicle supplies, hobby supplies, tobacco smoke.

Sick Buildings

In recent years, indoor air quality problems have been observed in buildings with energy efficient construction. The problems have been traced to inadequate air exchanges. Buildings are usually constructed to minimum standards for air exchange. After a few years dust and grease clog vents and airways, restricting flow and air exchange below minimum standard.

Effects of indoor air pollutants range from irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue, to respiratory disorders, heart disease, and cancer. But there is considerable uncertainty about the concentrations or periods of exposure that produce them.

Organic compounds – solvents, fuels, sealants, and other chemicals that contain carbon– are among the most dangerous indoor air pollutants. Used extensively in industry and at home, they are also found in the products of combustion such as the exhaust gases from vehicles, and smoke plumes from incinerators, wood stoves, and fireplaces. Some organics, such as benzene, are known to cause cancer or have been implicated as suspected carcinogens. Limited data are available on the ambient levels of various common organic materials in air.

Steps to alleviate the problems of indoor air include modifying building codes, educating the public in preventive and remedial measures, introducing legislation to limit emissions of various compounds, and banning certain solvents.

Radon

Radon is a radioactive, colourless, odourless, and tasteless gas. It is produced by the natural breakdown of radium in soil and rock. Breathing radon has been associated with lung cancer in those exposed to high doses of the gas (such as uranium miners) and accounts for up to 5% of all lung cancer deaths.

Outdoors, radon is usually present at such low levels that there is very little risk. But radon can enter a building through cracks and holes in the foundation and accumulate at concentrations that may pose a hazard. Manitoba has some of the highest radon levels in Canada.

So many factors contribute to the accumulation of radon that it is difficult to predict whether a particular building will have high concentrations. Radon accumulation has been incorrectly attributed to energy efficient construction, based on the assumption that radon becomes trapped within the well-sealed interior. Surveys show no conclusive link between building construction type and radon concentration.

Measures to prevent radon build-up include better foundation sealing to block the entry of radon, and sub-slab ventilation to remove radon below the structure.

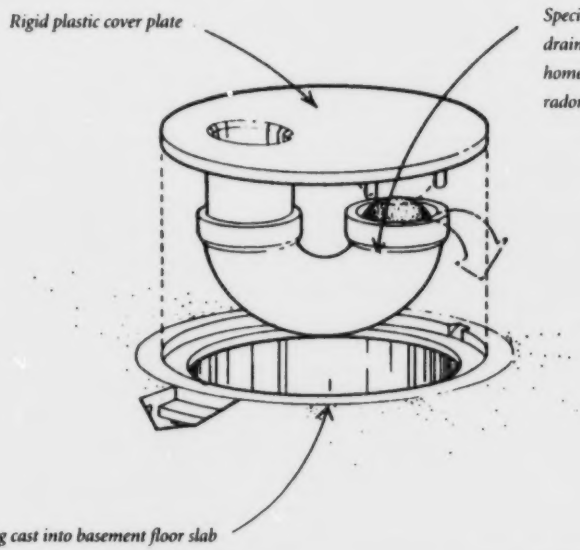
There is considerable debate about the amount of risk associated with different levels of exposure. The United States Environmental Protection Agency has judged indoor radon to be a serious environmental concern. On the other hand, Health and Welfare Canada has not accepted the Environmental Protection Agency's assessment and is involved in several studies to determine the degree of risk of exposure to low dosages. Given these judgements and the elevated radon levels found in Manitoba communities, radon is likely to become a growing public concern in the 1990s.

Manitoba responded to the concern in October 1989 with a comprehensive Radon Action Plan, the first of its kind in Canada. Activities started under the program include:

- production of *Radon: An Interim Guide for Manitoba Homeowners*
- public presentations and industry workshops
- a Radon hot-line to deal with inquiries
- a province-wide survey to determine the extent of the radon problem outside Winnipeg, to complement a similar study done in Winnipeg
- a province-wide survey of schools by the Manitoba Association of School Trustees
- research on radon control methods in homes.

Radon Trap

Radon trap to block the gas from entering a Winnipeg dwelling. Almost every home has a measurable amount of radon, but homes should be tested individually since levels can vary dramatically and are difficult to predict.


Rigid plastic cover plate
Special trap to allow water to drain but prevent entry into home of soil gas including radon
Retaining ring cast into basement floor slab

Source: Manitoba Environment

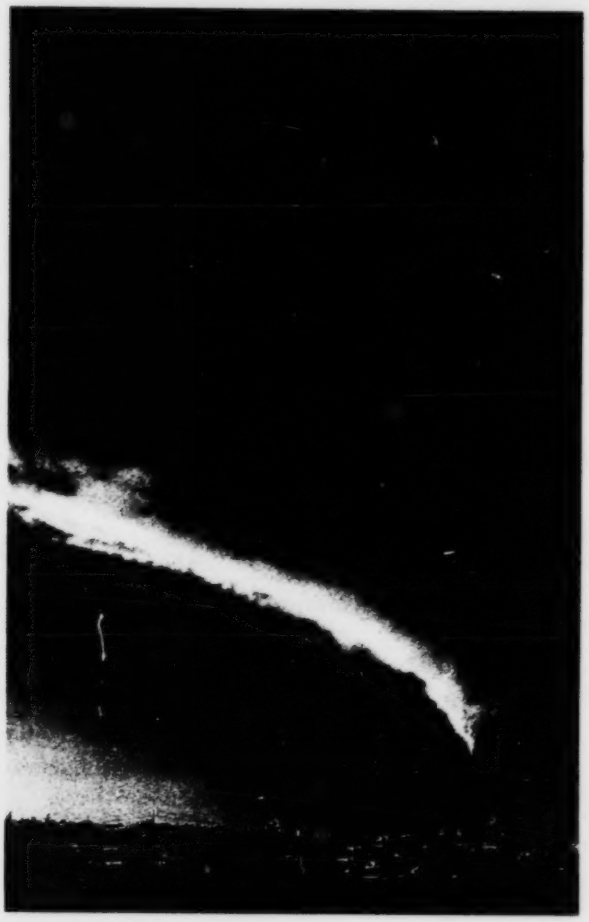
Long Range Transport of Air Pollutants

Gases such as sulphur dioxide and nitrogen dioxide react with moisture in the air to form acid compounds that may fall to earth many kilometres from the original source. Manitoba's two northern smelters have been identified as minor contributors to acid deposition, more commonly known as acid rain, in eastern Canada. Acid rain has been linked to fish kills and forest dieback.

A federal/provincial program is currently studying the effects of acid rain and ways of reducing the emissions that cause it. Several studies are under way to compare the lung functions of children exposed to acidic air pollutants in comparison to children in non-polluted areas.

The chemical quality of snow and rain – often an excellent indication of the cleanliness of air since rain and snowfall can scrub contaminants from air – was measured at Brochet, Gillam, Island Lake, Norway House, and Pointe du Bois under a provincial program. The federal government also monitors precipitation quality at McCreary and Island Lake as part of its Canadian Acid Precipitation Monitoring Program.

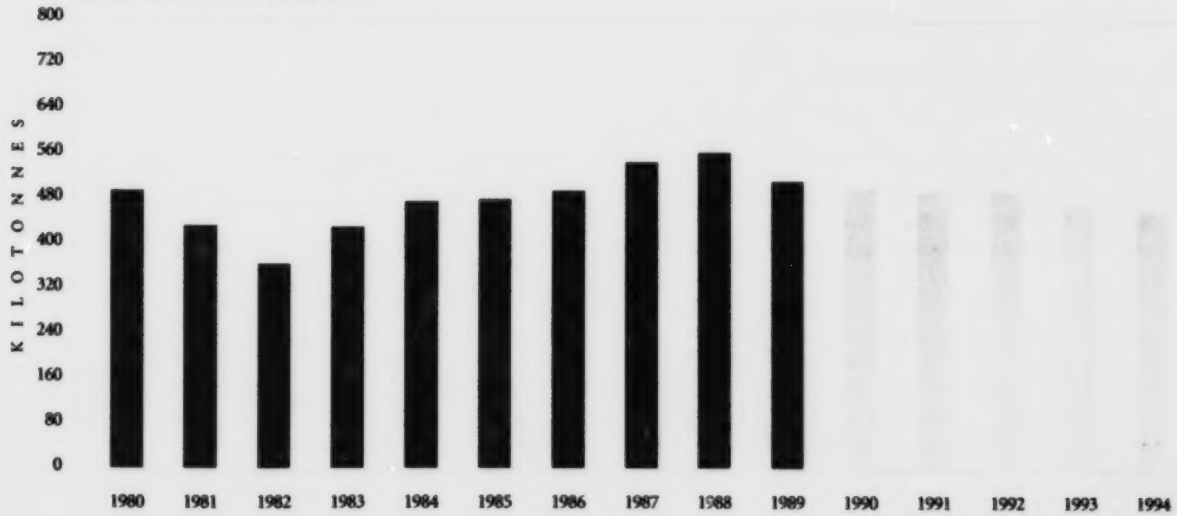
In addition to reducing sulphur dioxide emissions, Manitoba participates on various federal/provincial committees to ensure coordinated research and monitoring.



Tall smoke stacks improve local air quality but can cause environmental damage elsewhere, sometimes thousands of kilometres away.

MANITOBA EMISSIONS OF SULPHUR DIOXIDE

Emissions for 1990 to 1994 are projected.



Source: Manitoba Environment

Global Warming

The greenhouse effect refers to the natural warming of the earth's atmosphere. It is caused by gases that blanket the earth, trapping much of the heat that would otherwise be radiated back into space.

We are enhancing this greenhouse effect by adding carbon dioxide, methane, nitrous oxide, ozone, and CFCs to the atmosphere through industrial and agricultural activity, combustion of fossil fuels, and forest clearing by burning. These greenhouse gases add to the blanket of gases already in the atmosphere, trapping more heat and warming average surface temperatures over the globe.

In 1987, CO_2 accounted for about 66% of Canada's known man-made greenhouse gas emissions. CFCs, a group of industrial chemicals also known as freon gases, were responsible for 17% of the greenhouse effect. Methane and nitrous oxide contributed 12% and 5%. The amount of CFCs in the atmosphere has increased sharply in recent years, as their industrial use grows.

Scientists estimate that greenhouse gas concentrations could double over pre-industrial levels by as early as the year 2010. According to global climate computer models, doubling would cause a 2°C to 5°C warming of the Earth's annual temperature.

Winnipeg "Moves" South

For a doubling of greenhouse gas concentrations, average summer temperatures in the province could rise by about 3°C, and average winter temperatures by about 5°C. Average temperatures at Gillam could become more like those at Norway House, Norway House more like Winnipeg, and Winnipeg more like Minneapolis. Cold spells would still occur, but they would be shorter and less frequent.

There could be slightly more rainfall, but higher temperatures would boost evaporation, leaving Manitoba drier. The southeast corner of the province could become as dry as southeast Saskatchewan. Floods may still occur, but less frequently.

Preventive Measures

International negotiations are under way towards achieving a unified strategy to address global warming. The Canadian Council of Ministers of the Environment has proposed a National Action Strategy on global warming. The strategy aims to stabilize emissions of CO_2 and other greenhouse gases at 1990 levels by the year 2000. Reducing CO_2 emissions by 2005 was recommended by the Toronto Conference on the Changing Atmosphere.

Manitoba's efforts include developing greenhouse gas inventories, developing and promoting energy management programs to reduce energy consumption, and promoting reforestation and forest fire prevention to reduce levels of CO_2.

Conservation, recycling, and the use of alternative energy sources would all help to limit the increases of greenhouse gases in the atmosphere.

Forest fires have particularly serious implications for global warming. Burning releases vast quantities of carbon dioxide and the fires eliminate forests which are capable of absorbing the gas.

The Ozone Layer

Ozone is a form of oxygen produced when the sun's rays break up and reform oxygen molecules. A pungent-smelling slightly bluish gas, ozone envelops the earth in a thin layer 15 to 35 kilometres above the earth's surface. It protects life on earth by absorbing most of the sun's damaging ultraviolet radiation.

Over the last 10 years, the ozone layer has been depleted as a result of infiltration into the upper atmosphere of a group of synthetic compounds known as chlorofluorocarbons (CFCs) and halons. Under the sun's ultraviolet rays, molecules of CFCs and halons break down, releasing chlorine and bromine that attack the ozone.

Depletion of the ozone layer raises the spectre of increased sunburn, skin cancers, and eye cataracts in humans; reduced crop yields worldwide; and damage to small organisms at the base of the aquatic food chain, affecting marine life.

Each year, during the past decade, the ozone layer over the Antarctic has become thinner during September and October, creating a "hole" half the size of Canada. A similar, smaller hole has developed over the north pole, lasting for at least 6 weeks during March and April. Although formation of the holes is as yet unexplained, evidence points to CFCs and halons as the major causes.

CFCs are non-toxic substances used as coolants in refrigerators and air-conditioners, as blowing agents in the manufacture of foam insulation and padding, as propellants in spray cans, and as solvents for cleaning microchips and other electronic equipment. Halons are used mainly in fire-fighting equipment. Since both chemicals can be active for 100 years, the ozone layer will continue to be depleted for at least 100 years after the use of CFCs and halons has stopped.

Although restrictions on the use of CFCs in spray cans were introduced in Canada and the United States in the late 1970s, global levels of the chemicals in the atmosphere continue to rise at alarming rates of 5% to 6% per year. Manitoba accounts for about 2% of Canada's emissions of ozone depleting substances.

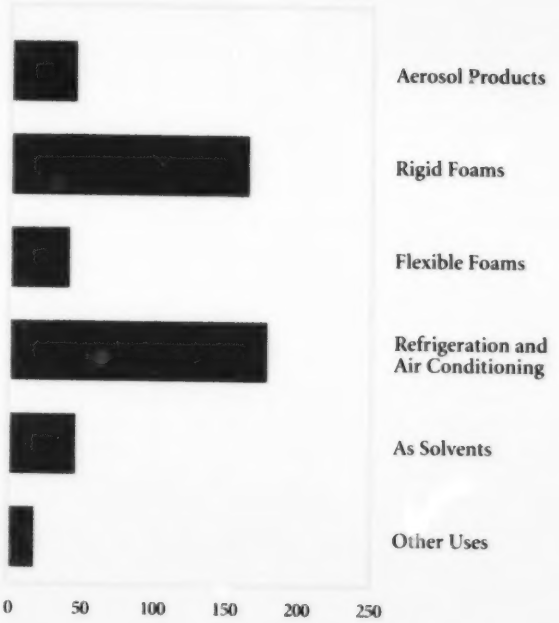
In September 1987, 24 nations, including Canada, signed an agreement to reduce the use of CFCs by 50% by 1999. The agreement, known as the Montreal Protocol, is a follow-up to the 1985 Vienna Convention for the Protection of the Ozone Layer. It came into force January 1, 1989, and has been ratified by Canada and 46 other countries.

The protocol limits the use of CFCs, bans the use of halons, and includes trade sanctions against non-participating countries. It places controls on the production of other ozone-destroying chemicals and establishes a timetable to control the consumption of five CFCs and three halons.

At the London Conference in June 1990, Canada was the first nation to ratify a strengthened protocol calling for the phasing-out of CFCs by 2000 and of other major ozone-depleting substances by 2005. Since then, Canada has announced a goal to phase out the use of CFCs by 1997 and the use of methyl chloroform and other major ozone-depleting substances by the year 2000.

USES OF CHLOROFLUOROCARBONS
MANITOBA 1987

Source: Manitoba Environment



Industry is now developing substitute chemicals and processes to reduce its dependency on CFCs. Butane and similar materials have proven effective substitutes as propellants in spray cans. Food containers are being made from paper products instead of plastic foam, and refrigerators are being developed to use helium as a coolant. Chemicals that can be substituted for CFCs must present little or no threat to the ozone layer.

A world-wide network of measuring stations, which includes a station in Churchill, has been set up to keep a close watch on the ozone layer. Environment Canada plays a leading role in this effort by operating the World Ozone Data Centre which collects and distributes data on the ozone layer.

Activities in Manitoba include preparing an inventory of amounts and locations of CFCs in the province, recycling, and preventing the release of CFCs in use. The province also takes part in a coordinated national effort through the Canadian Council of Ministers of the Environment, and has passed The Ozone Depleting Substances Act. Aim of these efforts is to reduce CFC emissions in the short term and eventually phase them out.

Industry Responds

Atmospheric emissions

Inco has incorporated two control measures into their operations at Thompson to reduce atmospheric emissions. The company rejects ore with a high sulphur content in a move to lower emissions of sulphur dioxide during smelting. It has also voluntarily agreed to reduce operations, and thus emissions of sulphur dioxide, when ambient levels exceed provincial objectives. Further reduction in emissions is still required to meet the 1994 targets specified in the regulation.

Energy-recovery programs

Programs undertaken by various companies such as Inco and Hudson Bay Mining and Smelting to recover energy for heating or use in processing have reduced energy consumption. Since most primary energy is provided from combustion of fossil fuels, this achievement lowers emissions to the atmosphere.

Rural grain elevators

In response to regulatory requirements to improve air quality in the workplace, most grain elevators have installed (or are installing) on-site collection devices to filter dust from indoor air rather than exhaust the dust directly outdoors where it would pollute the air.

Legislation and Regulation

The Manitoba Environment Act is the key provincial legislative tool for addressing and controlling developments that release pollutants to the atmosphere. As of January 1990, licences had been issued to 319 operations covering limits on atmospheric emissions, ambient air quality to be maintained, operating conditions, follow-up studies required, and restrictions on day-to-day procedures. Three regulations under The Environment Act address specific atmospheric sources. The Incinerator Regulation (MR 91/88R) bans the use of domestic and flue-fed incinerators and limits emissions to the atmosphere from industrial, commercial, medical, and research facilities that use incinerators. This regulation is currently under review with the intent of developing a broader approach.

Inco Limited and Hudson Bay Mining and Smelting Co., Limited Smelter Complex Regulations (MR 165/88 and 181/88) limit emissions of sulphur dioxide and particulates from these operations. Under these regulations, emissions are to be reduced to 440,000 tonnes as of January 1, 1994. Manitoba chose to meet that challenge as part of its commitment to help combat acid rain problems in eastern Canada where emissions have been traced to Manitoba's smelter operations.

The Peat Smoke Control Regulation (MR 226/89) puts restrictions on the burning of peatlands in the southeastern part of the province to minimize the impacts from smoke generated by peat fires. A permit is required before a peatland development fire can be started.

Licences Restricting Atmospheric Emissions
(as of January 1990)

Asphalt Plants	9
Bulk Material Handling	12
Cement Plants	2
Concrete Batch Plants	14
Dairy Plants	2
Feed Mills	11
Food Processing	15
Foundries	14
Grain Elevators	11
Incinerators	112
Livestock/Poultry	1
Manufacturing/Industrial	72
Meat Processing	9
Mines	10
Pipelines	1
Pulp & Paper Mills	2
Rendering Plants	6
Scrap/Auto Wrecking	4
Seed Cleaning Plants	9
Sewage Treatment	3
Smelters	2
Steam Plants	8
TOTAL	**319**

Source: Manitoba Environment

Licensed or Regulated Incinerators
(as of January 1990)

Health Care	34
Schools	18
Crematoriums	9
Other	51
TOTAL	**112**

Source: Manitoba Environment

Additional regulations under The Environment Act are currently under development to address:

- **asphalt plants** - would limit emission of particulates, odour, noise, and dust from new and existing stationary plants
- **stack sampling** - would require a standard reference method for source testing of particulate emissions from stationary and portable sources
- **stack sampling facilities** - identifies stack sampling facilities required for compliance testing of stationary and portable sources.

The province has also adopted objectives and guidelines on ambient air quality, noise, and atmospheric emissions to protect atmospheric quality.

Under The Public Health Act, an Atmospheric Pollution Regulation (MR 320/88) addresses situations where nuisance conditions might prevail, such as localized problems with smoke from wood-burning stoves.

Passed in March 1990 by the province, The Ozone Depleting Substances Act provides the legislative framework needed to reduce the production and use of substances that deplete the ozone layer. It also provides consumers with recourse if they are sold products containing or made with CFCs or halons and sets standards for consumer notification.

In addition to provincial statutes, bylaws have been enacted by local governments to control incineration and noise.

Educational Programs

Manitoba Environment

Pamphlets on air quality and acid rain, technical reports on air quality in the province and special projects, and public speakers are some of the educational aids available to the public.

Manitoba Health

This department promotes public education to make citizens aware of the increasing risk of contracting skin cancer from prolonged exposure to ultraviolet radiation from natural and artificial sources, including sunbathing and use of commercial sun tanning facilities. Adverse effects on health from exposure to other environmental hazards are assessed on a regular basis.

Manitoba Energy and Mines

Public awareness programs such as energy audit services, technical reporting, public speakers, and an energy information centre provide energy management education to reduce energy related emissions and promote information on indoor air quality.

Air Waste Management Association

The association sponsors local technical meetings and speciality conferences on air quality and related issues.

Trends

Carbon monoxide in Winnipeg ——— **Better**
Ambient levels have declined from 1974 to 1987.

Sulphur dioxide in Flin Flon ——— **Worse**
Although average yearly levels of SO_2 generally fall within acceptable limits, in 1990 levels exceeded the 1-hour maximum acceptable level for 249 hours on 85 days spread fairly evenly over the year.

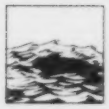
Nitrogen dioxide in Winnipeg and Brandon ——— **Same**
Levels have held steady within air quality objectives since Manitoba Environment started monitoring in the mid 1970s.

Particulates ——— **Worse**
In Winnipeg, for example, particulate levels rose above the 24-hour maximum acceptable limits more often in the second half of the 80s than in the first half.

Lead levels ——— **Better**
Levels are well below 24-hour guidelines and continue to decline because of the introduction of unleaded gasoline and the phasing out of leaded gasoline.

Ambient air quality data ——— **Same**
Data are limited especially in rural Manitoba. Monitoring stations are located in Winnipeg, Brandon, Flin Flon, Thompson, and St. Francois Xavier and measure only six pollutants.

Work on air contaminants ——— **Same**
To date, little work has be done on air contaminants such as organics and heavy metals.



WATER

Water is plentiful in Manitoba. Our lakes, rivers, streams, and wetlands, which cover one-sixth of the province, hold about 900 trillion litres. Three of the 15 largest lakes in Canada are in Manitoba. Our aquifers contain some 700 trillion litres of groundwater, and the atmosphere over the province holds another 34 billion litres.

Water is one of our most precious natural resources. As rain and snow it nurtures our crops, forests, and grasslands, replenishes our aquifers, and restores levels in lakes and streams. As groundwater, it provides drinking water for people and livestock, and supplies irrigators and industries. As surface water in lakes, rivers, and streams, it supplies us with drinking water, powers turbines for generating electricity, provides habitat for fish and wildlife, supports commercial, residential, and recreational activities, and assimilates wastes.

Surface Water and Groundwater

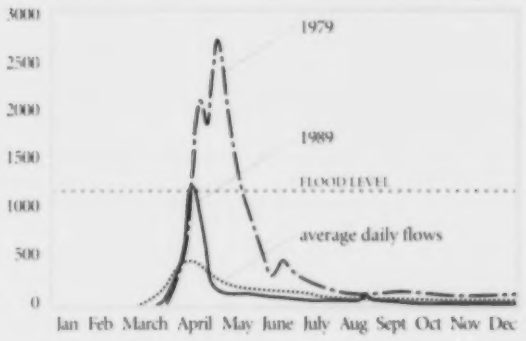
Although we have lots of water, it is seldom present where and when it is needed. Most of our surface water is concentrated in central and northern Manitoba where it is inaccessible to population centres in southern parts of the province. And the greatest flows in our southern rivers develop in spring from snowmelt. In a typical year, the Red River carries three-quarters of its annual runoff from April to June.

Flows can vary greatly from year to year. In 1950, spring flows on the Red flooded 1,300 square kilometres of the Red River valley. Water levels rose 15 metres higher, and flows measured nearly 100 times greater, than in August of 1989 when levels dropped so low that town water supplies nearly dried up.

As water passes through our province, we use it over and over, often in ways that limit its use by others. Discharges of sewage to the Red River pose the risk of disease or infection to those who swim or otherwise have extensive body contact with the water downstream.

RED RIVER AT EMERSON - DAILY FLOWS

(cubic metres/second) *Source: Manitoba Natural Resources*



We are also vulnerable to uses of water outside the province. More than 70% of our streamflows originate in Alberta, the Territories, Saskatchewan, Ontario, Montana, the Dakotas, and Minnesota. Winnipeg's water supply, for example, is vulnerable to proposed developments on Shoal Lake in Ontario.

Surface water provides nearly 80% of Manitobans with their drinking water and serves as the focus of much outdoor recreational activity. The quality of our surface water is generally poorest in the southern part of the province, improving to pristine conditions in the north. Supplies are concentrated in central and northern Manitoba, far from the southerly basins where we have about 90% of our population and most of our agricultural land.

Groundwater is the main source of water in much of rural Manitoba. It supplies drinking water for many communities, meets most of the needs of industry and irrigators, and represents an important and reliable source of water, particularly in times of drought.

Groundwater in the province is considered to extend only about 200 metres below the surface, since deeper aquifers generally contain brines and most wells are less than 100 metres deep. The total annual sustainable yield of all Manitoba aquifers has been estimated at 1.8 trillion litres.

The quality of our fresh-water aquifers varies from excellent to very poor. Quality is generally excellent to good in the major sand and gravel aquifers (Assiniboine Delta, Oak Lake, and Winkler aquifers) and fair to good in the carbonate rock aquifer.

Groundwater issues usually involve quality and allocation. Increasing salinity is a problem in the Elie and Winkler aquifers, which supply the communities of Elie and Winkler. Arsenic has been found in the aquifer that supplies the community of Notre Dame de Lourdes. Allocation is one of the key issues in a proposal to supply the Gladstone-Westlake area with water from Lake Manitoba or the Assiniboine Aquifer.

All Manitoba surface waters drain into Hudson Bay, a major marine environment under federal jurisdiction. Impact on the bay is the least researched aspect of Manitoba's water resource. Total loadings of various constituents that reach the bay are likely to be minor and can only be grossly estimated as data are extremely sparse.

SURFACE WATER – PERCENT SUITABILITY FOR USE

USE	QUALITY	REGION				
		Grassland	Broadleaf / Mixedwood	Northern Coniferous	Northern Transition/Tundra	Winnipeg
Human Consumption (1988)	Minimal treatment	<1	21	64	>95	Not used
	Extensive treatment	>99	79	36	<5	Not used
	Not suitable	<1	<1	<1	<1	Not used
Fish	Good quality	25	76	74	81	<1
	Poor quality	56	23	23	19	>99
	Not suitable	19	1	2	<1	<1
Livestock	Good quality	88	>99	>99	>99	33
	Poor quality	7	<1	<1	<1	45
	Not suitable	5	<1	<1	<1	22
Irrigation	Good quality	77	85	98	>99	>99
	Poor quality	17	9	<1	<1	<1
	Not suitable	6	6	2	<1	<1
Industrial	Good quality	3	16	34	63	<1
	Poor quality	91	82	66	37	>99
	Not suitable	6	2	<1	<1	<1
Recreation	Swimming	22	59	53	93	<1
	Incidental contact	74	41	47	7	56
	No contact	4	<1	<1	<1	44

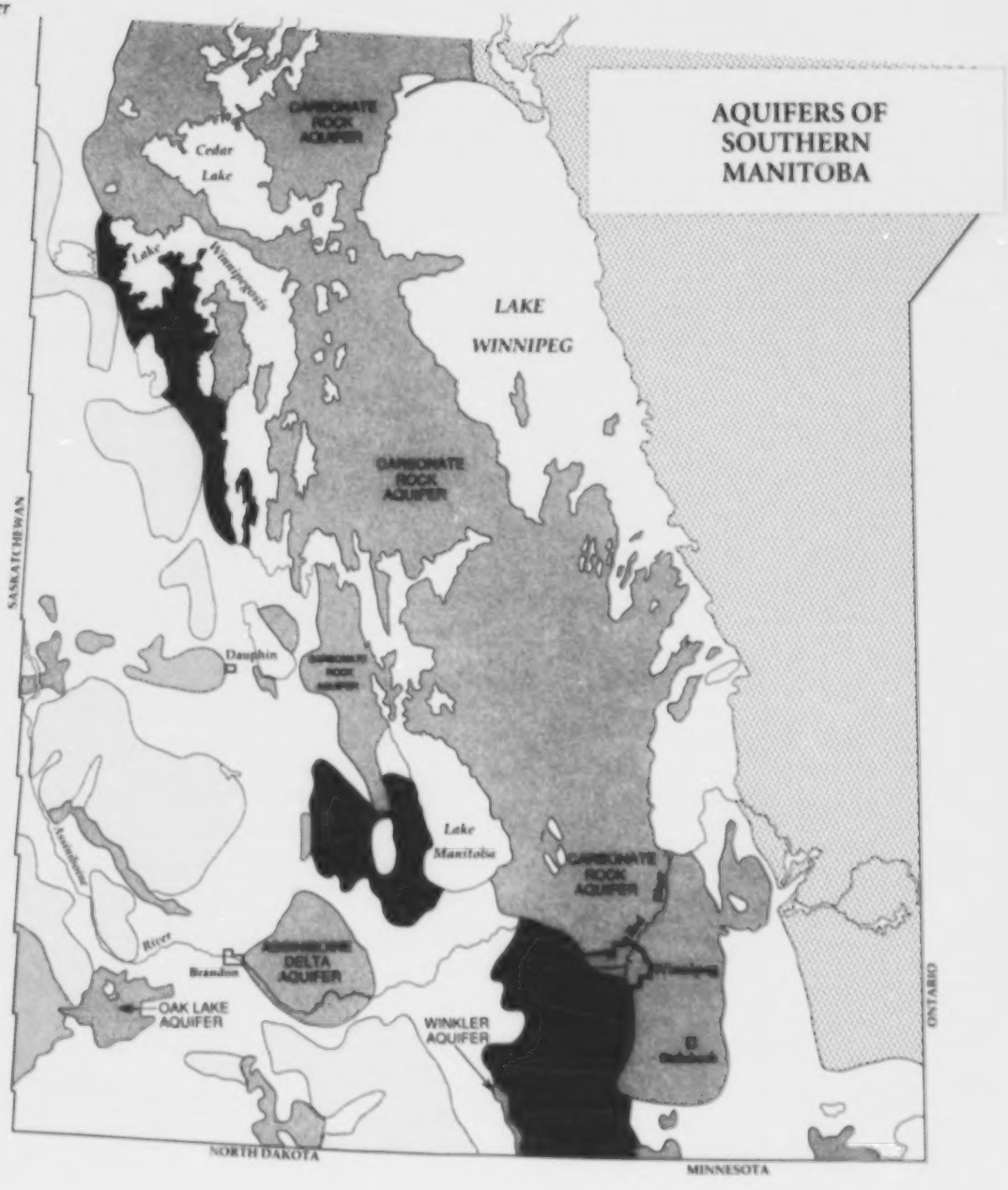
1. < means less than; > means greater than. 2. Suitability for use does not necessarily imply either that supplies are adequate or that such uses occur. The chart refers only to the suitability of surface waters in each region. 3. Winnipeg draws its water supply from outside the Winnipeg region. Water in Winnipeg, such as in the Red River and stormwater retention ponds, is not used for drinking.

GROUNDWATER – PERCENT SUITABILITY FOR USE

USE	QUALITY	REGION				
		Grassland	Broadleaf / Mixedwood	Northern Coniferous	Northern Transition/Tundra	Winnipeg
Human Consumption	Minimal Treatment	10	60	70	No data	10
	Extensive Treatment	70	30	25	No data	65
	Not Suitable	20	10	5	No data	25
Livestock	Good quality	70	80	85	No data	Not used
	Poor quality	20	10	<1	No data	Not used
	Not suitable	10	10	5	No data	Not used
Irrigation	Greenhouses	20	20	80	No data	<1
	Field crops[2]	10	70	10	No data	75
	Not suitable	70	10	10	No data	25
Industrial	Good quality	75	90	90	No data	75
	Poor quality	25	10	10	No data	25
	Not suitable	<1	<1	<1	No data	<1

1. < means less than; > means greater than. 2. Field crops in Manitoba are often irrigated with groundwater that does not meet the guidelines.

Source: Manitoba Environment, Manitoba Natural Resources



EXTENSIVE MODERATE TO HIGH YIELD AQUIFERS

EXTENSIVE LOW YIELD AQUIFERS

VARIABLE

MINIMAL TO NONE

PRECAMBRIAN ROCK AND SAND AND GRAVEL

SALTY GROUNDWATER AREAS

NAME	ESTIMATED YIELD Cubic metres / year
Assiniboine Delta Aquifer	89 000 000
Carbonate Rock Aquifer	789 000 000
Oak Lake Aquifer	18 000 000
Winkler Aquifer	500 000
TOTAL	896 500 000

Note : By comparison in 1988 the City of Winnipeg was supplied with 110 000 000 cubic metres of water.

Source: Manitoba Natural Resources

Impacts on Water

Our impact on surface waters in Manitoba is greatest in the more densely populated, southern areas of the province where water is in shortest supply. Southern waters bear the greatest burden of waste discharges. On the other hand, major manipulations of water occur in northern parts of the province well removed from large population centres. Groundwater is generally subject to localized impacts on quality and quantity.

Land Use

Agriculture, forestry, urban development, and recreational development are typical of land uses with impacts on surface water and groundwater.

Excessive tillage typical of summer fallowing (a declining practice), and applications of pesticides and fertilizers are the major agricultural practices that can contaminate groundwater supplies, encourage soil erosion, and release agricultural chemicals to surface waters. Silt-clogged streams, ditches, and drainage channels are a problem throughout the Grassland Region where dredging and other operations to restore flows annually costs the provincial and municipal governments thousands of dollars.

Herbicides can be detected in southern Manitoba rivers and occasionally even in potable water sources for communities, although they are still below the *Guidelines for Canadian Drinking Water Quality*. Livestock operations are particularly rich sources of nutrients. Even a little runoff from a feedlot can induce massive plankton blooms, proliferations of aquatic weeds, and other telltale signs of eutrophication. (Eutrophication is the artificial acceleration of a lake's natural aging process. It is caused by the addition of nutrients such as phosphorus and nitrogen.)

Education and voluntary action by farmers are the keys to solving many of these problems. Manitoba Agriculture promotes reduced tillage and other conservation practices. Forty-three soil and water associations across agricultural Manitoba have involved farmers and Manitoba Agriculture in promoting conservation practices. The department advises farmers on environmentally and economically optimal rates for applying fertilizers. Manitoba Environment with Manitoba Agriculture jointly offer a pesticide applicators course that is mandatory for commercial applicators. A program for recovering chemical containers has also been established (*see* **Waste Management**). The province's conservation districts take direct action to safeguard their water resources. The Turtle River Watershed Conservation District, for example, establishes shelterbelts and buffer zones along district streams.

Forest harvesting can disrupt the surface cover, encouraging erosion. When trees are cut down in groundwater recharge zones, aquifers can receive large amounts of water that would otherwise have been held near the surface by the trees. If the water carries herbicides applied improperly during reforestation, it can contaminate aquifers and nearby lakes and rivers. A recent example involved hexazinone contamination of shallow aquifers underlying two reforestation plantations in the Agassiz Provincial Forest near Beausejour. Hexazinone, the active ingredient in the herbicide used to kill competing vegetation in the tree plantations, should not have been used because of sandy soils.

Urban developments demand water for consumption and waste assimilation, putting exceptional stresses on water resources. Surface water and groundwater supplies are affected by run-off that has picked up chemicals used to treat lawns and gardens, soot and other particles falling from chimneys and smokestacks, and car exhaust residues lying on the streets.

Recreational developments put stresses on aquatic life when they use sewage disposal methods that promote eutrophication. Gull Lake, near Stead in southcentral Manitoba, is frequently choked with weeds by the end of the summer, leading to midwinter oxygen depletions that suffocate fish. Conditions in the lake are caused by development 10 times greater than the lake's ecological carrying capacity and by the release of sewage from septic fields and privies to the soil with little capacity for holding nutrients. Elsewhere, power boating stirs up bottom sediments and accelerates shoreline erosion, encouraging eutrophication.

Demands for "clean" water are often met with chemical applications to control algae, weeds, and pests such as leeches and swimmers' itch. Even golf courses can be a cause for concern if proper care is not taken in the choice and application of chemicals, which can drain into nearby streams.

Pesticides Detected in Manitoba Surface Waters (1983 to 1990)

	Grassland	Broadleaf/ Mixedwood	Northern Coniferous	Northern Transition/Tundra	Winnipeg
Alpha BHC	•	•	•	•	•
Gamma BHC	•	•	•		•
Azinphos-methyl	•				
2,4-D	•	•	•		•
MCPA	•				•
Triallate	•	•			
Trifluralin	•	•			
Bromoxynil	•	•			
Diclofop-methyl	•	•			
Dicamba	•				
2,4-D-P	•				
2,4,5-T	•				
Atrazine	•				
Simazine	•				

Source: Manitoba Environment

Aquatic Life and Water Quality

Aquatic life can contaminate water supplies as well as signal the presence of contaminants in water.

The presence and abundance of certain types of algae, known as cyanophytes because of their blue-green pigments, signals an abundance of phosphorus, nitrogen, and other nutrients. Aquatic plants such as water celery and different species of pondweed react like living litmus paper to indicate acidity in the water. They can also give some idea of relative amounts of total dissolved minerals. Invertebrates such as insects, clams, and crayfish usually have such specific environmental needs that their presence or absence can signal a recent change in water quality.

Algae, large plants, bacteria, and fish can also lower water quality. Algae and large plants that grow on excessive nutrients can render surface waters unsuitable for recreation, uninhabitable by fish because of oxygen depletion, and toxic to some mammals such as cows and dogs. Bacteria capable of "eating" iron can impart foul tastes and odours to potable water supplies. Another type of bacteria, working on sulphide mine tailings near Fox Lake and Sherridon, generated sulphuric acid that leached into nearby water bodies, threatening several important fisheries.

Carp are notorious for their "rooting" behaviour which roils the water and destroys beds of vegetation. When carp muddy the water, they make it less suitable for waterfowl, a problem in the marshes at the south ends of Lakes Winnipeg and Manitoba.

Massive algae bloom and fish kills, signs of nutrient overloads that suffocate fish by using up oxygen.

Air Pollution

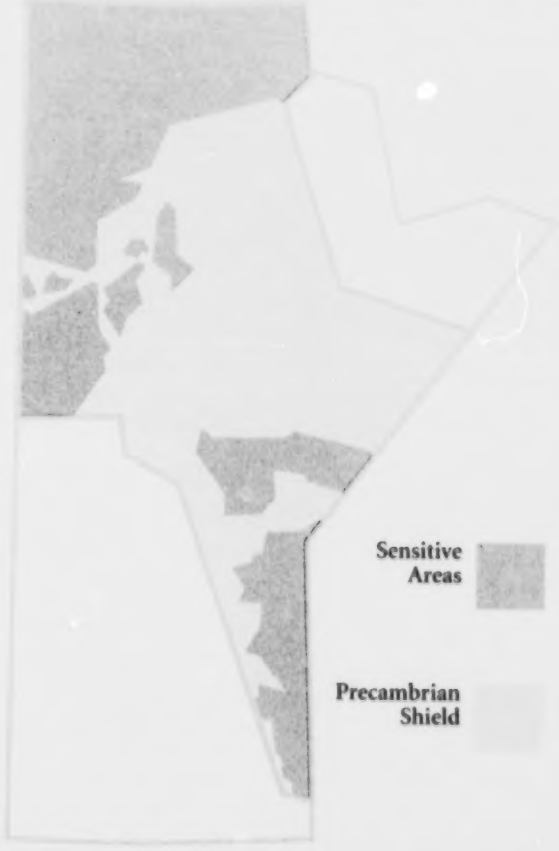
Although locations in the province sensitive to acid rain have been identified, no impacts on our lakes and streams have been detected. This is because our waters generally have a buffering capability that counteracts the effects of acids. Large amounts of limestone (calcium carbonate) that underlie much of Manitoba account for the buffering capability.

The fallout of zinc and copper near Flin Flon has increased concentrations of these metals in water and fish. The effects of long-range transport of pesticides, dioxins, mercury, DDT, and other chemicals toxic to a wide range of plants and animals have not been examined.

Accidents

The transportation of chemicals and a range of industrial processes do not normally affect our water resources unless chemicals or wastes are spilled. The impacts of such incidents are typically localized and short-lived. An example is the spill of 26,000 litres of hydrofluosilicic acid near Winnipeg's water intake structure at Shoal Lake on January 29, 1989. Fortunately, the spill was too far from the intake to threaten Winnipeg's water supply.

Regions of Manitoba considered sensitive to the effects of acid rain.



Another example is the fire of June 15, 1989, at Solvit, a Winnipeg chemical recycling facility. It resulted in the flushing of undetermined quantities of various solvents to local storm sewers.

Stream crossings along transportation corridors are particularly vulnerable to erosion and spills of hazardous materials. Erosion at stream crossings of the access road used to build hydroelectric generating stations along the lower Nelson River destroyed several kilometres of important brook trout habitat. Such incidents led to the formulation of guidelines to minimize the impact of stream crossings.

Outside Influences

Being on the receiving end of drainage from neighbouring jurisdictions, our transboundary waters are often subject to influences beyond our control. International concerns are referred to the International Joint Commission, and issues between Manitoba, Saskatchewan, and Alberta are addressed through the Prairie Provinces Water Board.

Saskatchewan's proposed Rafferty-Alameda dam developments in the upper Souris River watershed have raised concerns about water quality and quantity. The matter is still before the courts.

The Garrison Diversion Project in North Dakota has been a source of contention between North Dakota and Manitoba for several years. Revisions to the project have alleviated Manitoba's concerns about potential chemical and biological effects on the Red River and Lake Winnipeg. Progress is monitored by the Boundary Waters Office of Manitoba Natural Resources.

Mining and cottage developments have been proposed for Shoal Lake in Ontario, the source of Winnipeg's drinking water. Shoal Lake is managed through a Memorandum of Understanding which recognizes the interests of the various jurisdictions. A management plan for the entire watershed is under consideration by Ontario and Manitoba.

Residents of The Pas are worried about the impact of petrochemical developments in Alberta as well as water storage and pulp and paper projects in Saskatchewan. So far, Manitoba has had very little say in the control of these potentially damaging developments which are sited along the North and South Saskatchewan rivers, a major source of flows in our province .

Transboundary waters can introduce exotic species that may not be welcome in our lakes and streams. Exotic species likely to enter Manitoba and cause problems include zander (a large fish resembling walleye that is native to Europe), grass carp, zebra mussels, and Eurasian milfoil. Recent introductions of zander in North Dakota and grass carp in Alberta pose a threat to Manitoba fish species. The zebra mussel, infamous for extremely rapid reproduction and subsequent blockage of water intakes, could be introduced from boats transported from the Great Lakes. Eurasian milfoil, an aquatic weed whose growth interferes with boat passage, may be introduced from the holds or the propellers of boats from southern Ontario,

British Columbia, or the United States. The rainbow smelt, a fish that could threaten Lake Winnipeg's whitefish and walleye fisheries, was discovered recently in Lake Winnipeg. It probably entered Manitoba from Red Lake, Ontario, by way of the Winnipeg River.

Water Shortages

Water shortages, particularly in the Grassland Region, threaten the viability of communities and farms. The province has taken several steps to ensure a steady supply, including:

- enlarging the Stephenfield Reservoir for the town of Carman
- enlarging Jackson Lake for the villages of Austin and MacGregor
- delivering water from the Assiniboine River to the La Salle River to meet the regional needs of the Sanford area.

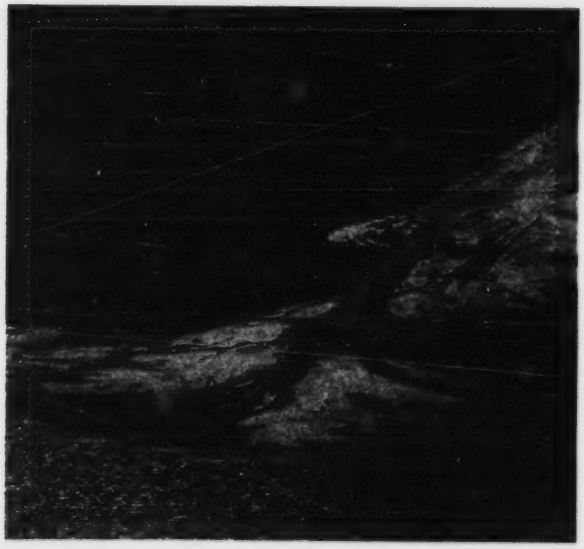
Considerable effort is under way to determine the most cost-effective and environmentally sound ways of supplying water to farms and communities in the Pembina Triangle.

DRAINAGE AREAS

	Sq. Km.	%
Manitoba	650,000	41
Other Canada	800,300	50
United States	142,500	9
Total	1,592,800	100

Diversions, Drainage Works, and Storage Projects

Water storage projects in Manitoba generally offer flood protection or supply water to meet the needs of hydroelectric generating stations, communities, or agriculture. Our three largest storage reservoirs are natural lakes with outflows controlled to maintain high water levels. Lake Winnipeg, Cedar/Cross Lake, and Southern Indian Lake were developed to supply hydroelectric generating stations. Most reservoirs have evolved into multi-use facilities where recreational and other uses sometimes conflict with original purposes.



Deepening or widening channels and eliminating bends in drainage works increases the speed and volume of flows, carrying silt into lakes and drying out wetland habitat.

STORAGE CAPACITY OF MANITOBA RESERVOIRS
(millions of litres)

Region	Stored Volume	% of Total Available
Grassland	478,000	32
Broadleaf/Mixedwood Forest	5,377,560	8
Nothern Coniferous Forest	42,135,000	6
Northern Transition/Tundra	3,636,400	4

Source: Manitoba Natural Resources, Manitoba Hydro

In the largest diversion of water in Manitoba, some 700 cubic metres per second – equivalent to the flow of the Winnipeg River – is channelled off from the Churchill River system to the Burntwood-Nelson rivers system to run hydroelectric generators. The longest serving diversion is the 159-kilometre aqueduct from Shoal Lake to Winnipeg which delivers 3.5 cubic metres of water per second – enough to fill seven bathtubs every second. Also of significance are diversions designed to shunt floodwaters around or away from communities, such as the Red River Floodway around Winnipeg and diversions at Portage la Prairie and Ste. Rose du Lac.

Drainage projects are generally built to enhance agricultural production, by reclaiming land, by allowing earlier access to fields in spring, or by removing excess rainfall during the growing season. Although most drainage works make the difference between farming or not farming an area, they dry out some 750 hectares of wetland every year. Reproduction of waterfowl, fishes, frogs, and salamanders suffers, and aquifer recharge rates can decline. Drainage works are one of the causes of the decline in fishery harvests on Dauphin Lake (*see* **Fish**).

Diversions can "dewater" aquatic habitat, as in the case of Northern Indian Lake which shrank to half its size when the Churchill River Diversion was opened. Flows along the original channel can drop to the point where the current can no longer keep the channel fully open. Problems for receiving waters include greater flows, scouring of stream beds, shoreline erosion, and higher silt and trash loads such as occur on the Burntwood River at Thompson.

By lowering source waters, diversions make less water available to dilute sewage, industrial effluents, and other wastewater discharges. Receiving waters in turn have to absorb massive injections of chemically different water.

Diversions can eliminate species, or introduce new ones, as in Lake Manitoba where black bullheads first appeared following construction of the floodway diversion near Portage la Prairie. Algae and aquatic plants may flourish or wane depending on murkiness, current speed, and the availability of nutrients. In some cases, mercury in sediments is changed by bacteria into a form that is easily absorbed by fish, as happened along the Churchill River Diversion.

In the grasslands, reservoirs tend to improve water clarity and to create fish habitat, sometimes leading to the development of important sport fisheries, such as the one at the Lake of the Prairies. Elsewhere, reservoirs can alter fish and wildlife habitats and cause murkiness and temperature changes. They also tend to trap nutrients and various toxics that become incorporated in sediments. Changes in flow patterns, caused by operation of northern reservoirs, particularly if they store water in summer and release it in winter to meet high energy demands, can destroy spawning grounds of whitefish and alter nutrient recycling. Impacts on aquatic life are often similar to impacts caused by diversions.

The construction of major water projects has cultural and socioeconomic impacts when it forces families, and even entire communities, from their homes. Families in the Assiniboine valley near Drapmore were forced to move before construction of the Lake of the Prairies reservoir, and the people of Chemawawin were relocated to Easterville during construction of the Grand Rapids dam. The traditional lifestyles and livelihoods of the communities of Nelson House and South Indian Lake, where people depend on the fishery resource, were severely affected by the Churchill River Diversion. Flow and level variations on the Nelson River have disrupted traditional recreational and economic activities and the travel routes of people in Cross Lake.

Measures to reduce socioeconomic impacts continue to be negotiated and put into effect. Many of the ill effects of the Lake Winnipeg Regulation on Cross Lake are to be eliminated by a weir built at the lake's outlet, giving local people more opportunities to use and enjoy the lake.

All water developments are designed to offer benefits, from countering water shortages to harnessing energy. But their benefits must be evaluated in light of their impacts. Mechanisms to ensure a proper evaluation include the approvals and licensing process under The Environment Act, the provincial Water Strategy, and the water permit system administered by the Water Resources Branch.

1987 Mean Residues of Metals and Pesticides in Fish from Five Major Rivers in Southern Manitoba

		Metals (µg/g)									Chlorinated Organics (µg/kg)				
Location	**Species**	As	Cd	Cu	Cr	Pb	Hg	Ni	Se	Zn	PCB	DDT	Mirex	Methoxychlor	Chlordane
Assiniboine River at Lake of the Prairies	Walleye	0.03	<0.1	0.30	<0.5	0.52	1.22	<0.50	0.57	4.23	50.5	3.11	1.14	<2.00	1.34
	Common Sucker	0.04	<0.1	0.67	<0.5	0.90	0.19	<0.50	0.47	3.84	44.8	4.91	<1.10	<2.00	1.36
	Shorthead Redhorse Sucker	0.04	<0.1	<0.20	<0.5	<0.50	0.20	<0.50	0.24	5.20	36.5	3.00	<1.10	<2.00	1.34
Red River at Emerson	Sauger	0.04	<0.1	0.32	<0.5	0.52	0.43	<0.50	0.42	4.28	1709.0	21.87	<1.10	<2.00	1.80
	Walleye	0.04	<0.1	0.40	<0.5	<0.50	0.47	<0.50	0.41	3.83	62.5	13.50	<1.10	<2.00	1.78
	Goldeye	0.02	<0.1	0.53	<0.5	0.66	0.33	<0.50	—	4.07	986.2	45.20	<1.10	2.10	2.04
Saskatchewan River at The Pas	Walleye	0.06	<0.1	0.30	<0.5	<0.50	0.18	<0.50	0.39	4.08	<41.0	2.46	<1.10	<2.00	1.34
	Goldeye	0.02	<0.1	0.73	<0.5	<0.50	0.17	<0.50	0.71	4.25	<41.0	3.77	<1.10	2.17	1.38
	Common Sucker	0.05	<0.1	0.49	<0.5	<0.50	0.11	<0.50	0.41	3.76	38.9	2.68	<1.10	<2.00	1.35
Souris River at Souris	Walleye	0.03	<0.1	<0.20	<0.5	<0.50	0.51	<0.50	0.32	4.20	<41.0	2.53	<1.10	<2.00	1.34
	Common Sucker	0.02	<0.1	0.48	<0.5	<0.50	0.23	<0.50	0.23	4.56	<41.0	3.46	<1.10	<2.00	1.34
	Brown Bullhead	0.02	<0.1	0.45	<0.5	<0.50	0.28	<0.50	0.10	6.37	<41.0	2.77	<1.10	<2.00	1.34
Winnipeg River at Eaglenest Lake	Walleye	0.02	<0.1	0.80	<0.5	<0.50	0.47	0.57	0.16	5.40	622.5	8.26	<1.10	<2.00	1.35
	Northern Pike	0.02	<0.1	0.92	<0.5	0.56	0.69	<0.50	0.06	5.73	<41.0	2.78	<1.10	<2.00	1.34
	Common Sucker	0.01	<0.1	0.61	<0.5	0.50	0.25	<0.50	0.12	4.47	830.0	11.35	<1.10	<2.00	1.40

Source: Manitoba Environment

Waste Assimilation

Xenobiotics are toxic compounds such as organic wastes and certain metals that are directly toxic to different life forms or accumulate in tissues and induce chronic effects. Effects that become apparent only after long-term exposure are said to be chronic effects. Examples of xenobiotics include dioxins, polychlorinated biphenyls (PCBs), cadmium, and mercury.

Xenobiotics are often found in wastewater streams entering surface waters. Although limited sampling has not yet detected the presence of dioxins in Manitoba waters, routine monitoring of fish tissues frequently detects trace levels of PCBs and mercury.

Wastes with a biochemical oxygen demand (BOD) content strip oxygen from the water, suffocating fish and most invertebrates such as clams and insects. Examples include sewage and wastes from pulp mills and meat packing plants. Such wastes are often loaded with nutrients that promote the growth of algae and aquatic plants. During fall and winter, algae and plants decompose, further increasing the BOD load. Wastes with BOD content typically also carry high concentrations of bacteria.

Thermal wastes refer to cooling water released to surface waters from thermal electric generating stations, and discharges from air conditioning plants which are generally released to groundwater aquifers as part of a recirculating system. Thermal discharges to surface waters attract fish which may suffer thermal shock when the discharges stop. Thermal shock can be fatal. In December 1987, some 100 trophy channel catfish and other species were killed in Cooks Creek near Selkirk. In contrast, thermal discharges to aquifers are thought to be benign unless poor design or faulty construction allows cross-contamination between upper- and lower-level aquifers.

Runoff from snow and rain becomes a problem in urban areas and at industrial sites. It carries chemicals in runoff from lawns and gardens, soot and other particles from chimneys and smokestacks, or automobile exhaust residues lying on the streets. Runoff from urban areas often has elevated levels of BOD, bacteria, salts, nutrients, and silt. Runoff from industrial sites may also include xenobiotics.

Other types of wastes discharged to surface water or groundwater may include brines, acids, bases, and short-lived radioactive materials such as the carbon-14 isotope. These types of wastes have low toxicities and are normally treated by dilution.

Consumption

The impact of consumption on groundwater mainly takes the form of lower water levels. Except for natural fluctuations, groundwater levels in much of Manitoba are the same as they were 25 years ago. In and around Winnipeg, however, pumping has created a 30-metre drawdown cone, lowering groundwater levels well below the surface where artesian wells once flowed freely at the turn of the century.

Water levels of the Winkler Aquifer have also dropped noticeably, declining 3 metres in the last 15 years. A similar trend has been observed in the Sandilands Forest at Sandilands and Woodridge, possibly because of drainage works, reforestation, and greater water use.

Point sources of contamination can have drastic effects on groundwater quality. Leaky fuel tanks and poorly designed wells led to pollution in aquifers serving Birds Hill, Stonewall, Ashern, Flin Flon, The Pas, and others. Liquid industrial waste contaminated shallow sand and gravel aquifers near Brandon. Deep wells connecting saline aquifers with fresh aquifers lowered groundwater quality in the Winnipeg area. Pumping in the Winkler municipal well field slightly reduced water quality in the aquifer by inducing the upward movement of saline water.

Irrigation return flows typically contain high concentrations of nutrients and pesticides. They can lower water quality if they recharge an aquifer or enter a surface water body. Both possibilities were major concerns with the original design of the Garrison Diversion.

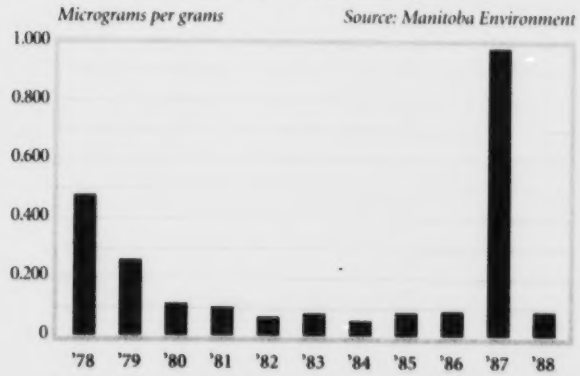
Petroleum Storage Tanks

Leaks from petroleum storage tanks are not easy to detect, and even trace amounts from these tanks can make well water unpalatable for drinking. Tanks installed in sand, gravel or limestone areas are of particular concern because petroleum products such as gasoline can percolate rapidly through these formations, contaminating large portions of underlying aquifers, as happened recently at Easterville, Brandon, Neepawa, and Swan River.

There are some 9,000 petroleum storage tanks in Manitoba. Just over one-third of them are considered safe installations because of special liners, fibreglass coatings, or cathodic protection. The other two-thirds will be upgraded or replaced under a proposed amendment to a regulation of The Dangerous Goods Handling and Transportation Act.

Each year, on average, leaks develop in about 40 tanks. Manitoba Environment inspects gasoline tank installations regularly. Under the amendment mentioned above, it will be mandatory to upgrade tank installations that do not pass inspection.

PCB CONCENTRATION IN THE GOLDEYE FROM RED RIVER AT EMERSON



The anomalous high concentration for 1987 is attributed to an unreported spill of some PCB-containing material.

The Water Strategy

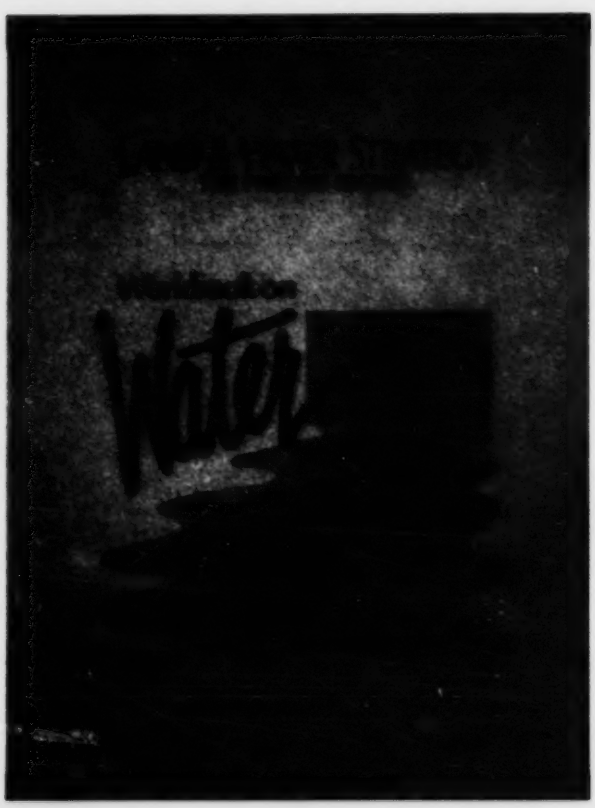
The traditional government response to water issues has been legislation. Although The Groundwater and Water Well Act, The Water Rights Act, The Water Resources Administration Act, The Water Powers Act, and their various regulations have generally been successful in curbing abuses, the changing demands of society tended to lead to increasingly complex regulations. The process became unwieldy – for regulated and regulators alike. A better approach was needed.

The strategy for dealing with water issues nowadays is to bring all stakeholders – government, industry, and the public – to the "bargaining table" to reach a consensus that leads to enlightened decision-making.

Sustainable Development

The Government of Manitoba has adopted the principle of sustainable development which is reflected in a proposed *Land and Water Strategy* with the following objectives:

- To sustain resources, enhance productivity, and improve environmental quality including human health.
- To improve and diversify income and job opportunities.
- To manage resource and related activities so as to preserve development options for future generations.
- To protect natural systems, maintain the genetic diversity of species and preserve the resilience and productivity of the ecological system.



Improving the quality of our lakes and rivers, and building carefully managed water retention projects enhances our quality of life, improves water supplies, and encourages tourism where none existed previously. Enhancing and protecting wildlife and fisheries habitats preserve species for our enjoyment, conserve genetic resources, and maintain ecosystem integrity.

Water Management Objectives

To achieve these goals, the province has adopted the following water management objectives which were drawn up with help from Manitobans across the province:

Water Quality - To protect and enhance the environmental quality of our aquatic ecosystems by ensuring that surface water and groundwater quality is adequate for all uses.

Conservation - To conserve and manage the lakes, rivers and wetlands of Manitoba so as to protect the ability of the environment to sustain life as well as to provide environmental, aesthetic, and economic benefits to existing and future generations.

Use and Allocation - To ensure the long term sustainability of the province's surface water and groundwater for the benefit of all Manitobans.

Water Management Infrastructure - To develop and manage the province's water resources to ensure that water is available to meet priority needs and to support sustainable economic opportunities and environmental quality.

Flooding - To alleviate human suffering and minimize the economic costs of damages caused by natural and man-made flooding.

Drainage - To develop a sustainable soil and water resource base from which a long term viable agricultural industry is obtainable.

Education - To increase and communicate knowledge of water conservation techniques, and foster support for water conservation among all Manitobans.

Zebra Mussels – Delaying the Invasion

Zebra mussels are small, brown-and-white-striped clam-like animals that pose a serious threat to our fisheries and other water users. They have been found as far west as Thunder Bay and could spread rapidly into our waters if steps are not taken now.

Native to the Caspian and Black seas of eastern Europe, the mussels were first spotted in Lake St. Clair in 1988, apparently brought from Europe in the ballast water of a freighter. They have since spread to all of the Great Lakes and could reach our waters in less than 5 years. Most of Manitoba is thought to be suitable for the spread of zebra mussels, which have few natural predators and multiply dramatically. Females can produce as many as 40,000 eggs a year over their 5-year life span.

The fingernail-sized mussels attach themselves to the intake pipes of municipal water supply systems and power plants, sharply reducing flows. In 1989, Ontario Hydro spent $6 million fitting its plants to prevent mussels from clogging their systems. The corporation has already cleaned more than 2 tonnes of mussels off its Nanticoke station on Lake Erie. The mussels could force the utility to reduce power output from generating facilities.

Zebra mussels cling to rocks, reefs, fishing nets, piers, buoys, and even other creatures such as clams and crayfish. Capable of forming colonies of up to 700,000 mussels per square metre, over 15 centimetres deep, they quickly cover fish spawning beds. They compete with fish by consuming large quantities of plankton, a very important link in the aquatic food chain.

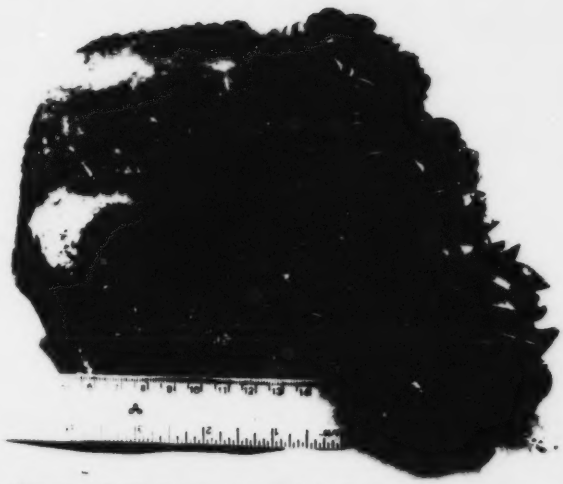
If left unchecked, the mussels could cause millions of dollars worth of damage to our fisheries, the Winnipeg Aqueduct and other public water supply systems, Manitoba Hydro's operations, and our tourism industry over the next 10 years.

In the United States, mussels forced a Michigan hospital to dismiss patients and cancel elective surgery, hiked Detroit Edison's annual maintenance bill by $500,000 a year, and threatened boaters on Lake Erie by sinking navigation markers.

Adult zebra mussels can survive out of water in moist conditions for up to 14 days. Larvae can also survive for long periods in water that contains sufficient oxygen, such as is found in bilges, engine cooling systems, and float-plane pontoons. Because of the large number of tourists, pleasure boaters, and anglers moving from the infested waters of the Great Lakes region to Manitoba, through Ontario and Minnesota, there is a high probability that the mussels could invade our lakes and streams. Anyone who moves boats and other equipment, or live bait, from Great Lakes waters to any inland waters could transfer the mussels.

Take the following precautions to help prevent or slow the spread of the mussels into Manitoba:

- Do not transport live bait fish from infested waters to other bodies of water. Exceptions are fish from well water or disinfected water. Note that it is illegal to transport live bait fish into Manitoba from other jurisdictions without a permit from Natural Resources.



Zebra mussels (Dreissena polymorpha). These clam-like animals plug the water intakes of private cottages, towns, cities, and industries, destroy fish habitat, and ruin shoreline recreation areas with accumulations of sharp shells and foul odours when they decay. If the mussels cross our watershed boundaries, in contrast to provincial boundaries, they are "in the door" and poised to infest our lakes and streams.

- Before leaving infested waters, clean boat hulls, motors, float-plane pontoons, scuba equipment, anchors, and any other equipment that may have been in the water. Check areas around drain holes, speedometer brackets, and other difficult areas to clean. If the surface feels grainy or rough, it could be harbouring young zebra mussels which are hard to see.
- Use a paint scraper or wash equipment thoroughly with a solution of 15 millilitres (1 tablespoon) of household bleach per 4.5 litres (1 gallon) of hot, soapy water. But do not use the bleach solution near any waterbody since it could damage aquatic life. Another option is to flush off the zebras with high-pressure water - at least 1,724 kilopascals (250 pounds per square inch).
- If the weather is hot and dry, leave the equipment out of the water for 2 or 3 days and the mussels will die. Some may drop off, but others may need scraping. Dispose of mussels in a garbage container or dump a good distance from any lake, stream, or municipal water system.

In Ontario, officials recognize that the "mussels are here to stay." Focus has switched to ways of controlling them to keep their impact to a minimum. In Manitoba, zebra mussels could surface in 2 to 5 years if nothing is done, longer if boaters take steps to avoid transferring them. Preventing or slowing their spread will also buy time for researchers to find an effective and safe treatment.

Collecting a water sample near Virden

Monitoring Quantity and Quality

Water issues typically involve quantity and quality, both of which require monitoring.

Stream flows and lake levels are monitored by a network of 344 federal and provincial stations across Manitoba. The data collected are used to operate water control structures, forecast floods and droughts, and conduct water-related studies.

The groundwater monitoring network consists of 470 monitoring stations located primarily in southern Manitoba. The stations monitor the effect of groundwater development on aquifers, provide reliable information on groundwater levels in the province, and provide data for determining the potential yield of aquifers. Water level is monitored at some 450 stations, water quality at 100 stations, and temperature at 45 stations.

Water quality concerns have traditionally been addressed on an ad-hoc, site-specific basis. It was not until 1972 that a comprehensive program for monitoring surface water quality was set up by the province. Since its inception, the monitoring program has grown to its present network of 50 sites (35 provincial, 15 federal). The effects of development and land use activities are monitored in watersheds, with monthly or quarterly sampling.

A program for monitoring groundwater quality in Winnipeg was set up in 1962 when the Red River Floodway was built. Monitoring stations are located in the Winkler and Assiniboine Delta aquifers and in the Selkirk area watercourses. Most of the stations are located in areas where quality may be affected by use.

Non-Government Organizations Lend a Hand

Non-government organizations and private individuals undertake projects that address broad water issues, and many industry leaders consider environmental protection in the initial stages of their development planning.

Members of the Zero Tillage Farmer's Association practise zero tillage to keep soil and chemicals from washing into lakes and streams. The Keystone Agricultural Producers Association supports soil conservation. Many cattle producers bar direct access to streams and provide alternate watering sources for their cattle.

Ducks Unlimited Canada maintains marshes and potholes to slow or even reverse the loss of wetlands and wetland habitat. People in the Turtle Mountain Watershed Conservation District and Deerwood Soil and Water Conservation Association build small retention dams on headwater streams to secure water supplies, check flooding, and conserve habitat.

Manitobans have become well informed and concerned about our aquatic heritage. Numerous citizen activist groups have been organized in response to specific concerns, such as the proposed developments at Shoal Lake, the effects of flow and water level variations on traditional lifestyles and livelihoods of Native peoples, eutrophication, and litter in our rivers.

Cooperative responses to shared concerns about water are a relatively recent phenomenon. Here are several examples of cooperation between the government, the public at large, and the private sector:

- **The Dauphin Lake Watershed Advisory Board** is composed of stakeholders from across the watershed who advise government on remedial action.
- **The Heritage Habitat Fund** has a board of directors, drawn from private and government personnel, responsible for administering the fund's rehabilitative projects.
- **A Citizen Monitoring Board**, which is comprised of community representatives and funded by Repap Inc., will be organized to oversee Repap's environmental monitoring program.
- **Hudson Bay Mining and Smelting Company and Manitoba Natural Resources** are developing a rainbow trout sport fishery on a lake that receives discharges of saline mine water.
- **The Black Bear Co-op** was established to supply potable water to a small community near Lac du Bonnet.
- **The International Coalition** promotes water conservation and water quality improvement in the Red River valley.

(top) Vestfold Marsh near Inwood in the Interlake parkland. One of Ducks Unlimited Canada projects, this wetland attracts up to 6,000 staging birds in the fall.

Trends

Chemicals in water ——— **Worse**
Herbicides have often been detected in water samples, even in potable water supplies.

Groundwater levels ——— **Same**
With few exceptions, there has been little change over past 25 years.

Water monitoring ——— **Better**
The network of monitoring stations has been greatly expanded since the 70s.

Wastewater treatment ——— **Better**
Treatment facilities continue to be upgraded throughout the province.

Levels of contaminants in fish ——— **Better**
Chemicals such as PCBs or DDT in fish samples have declined since the 70s.

Public participation ——— **Better**
Organizations and individuals are becoming increasingly involved in water monitoring and habitat rehabilitation programs.

(bottom) A Ducks Unlimited Canada wetlands improvement project. Built on private property west of Virden in 1978, the project benefits all wildlife in the area including big game, shorebirds, and muskrats.

FORESTS

Forests cover more than 60% of the province's lands, from the almost treeless tundra in the north, through the immense boreal forests of the Canadian Shield, to the aspen bluffs of the grassland. Their composition and distribution began to take their present shape about 6,000 years ago when glacial ice covering the province retreated northward, preparing the ground for the return of vegetation.

The province of Manitoba, which owns 93% of the forested land, is responsible for the care and use of our forests. Most of our provincial parks are sited on forested lands, with five of the parks occupying areas originally designated as provincial forests.

Natural problems of the forest range from fires and insects to drought and wind storms. They become our problems only when they interfere with human activities in the forest. One of the challenges of the forester is to time the harvesting of trees and other operations in ways that work with, not against, the natural life cycle.

Manitoba's forest industry directly employs 5,200 Manitobans and indirectly supports another 5,000. Tourism, outdoor recreation, trapping, and other industries are also linked to use of the forest.

Northern Transition/Tundra

This region takes in the northern reaches of the province to the shoreline of Hudson Bay and the Northwest Territories boundary. Tree cover is limited to the shores of lakes and rivers. Trees are stunted by short growing seasons, severe wind, frequent fires, and permafrost.

Black and white spruce together with tamarack, alder, and willow, are the major tree species, with some white birch, trembling aspen, balsam poplar, and jack pine in warmer, southern areas. To the south, tree cover improves in sandy soils and protected depressions with frost-free soils.

In some locations in the Northern Transition/Tundra, the ground sinks unevenly following exposure of ground ice around lakes and river channels, causing the trees to appear to be lurching about in all directions – the so-called "drunken forest."

There is no commercial use of the scattered forest stands in this region, but local people turn to the forest for shelter, fuelwood, and other subsistence needs.

Forest management is not routinely practised here. Fire, insects, and disease are not monitored and control programs are not carried out, but unusual tree mortality or damage in the region is reported and dealt with on an individual basis. During the last several decades no serious impacts other than forest fires have been documented.

More Than Timber

Forests have provided sustenance and shelter for people since the earliest times – fuel for fire, weapons for survival, wood for homesteads. Today they continue to contribute to our well-being, in more ways than just a source of planks and pulpwood.

Air and Water Conditioner

Forests serve as a carbon sink, converting carbon dioxide into the oxygen that we cannot live without. They anchor soils that help keep our water supplies clean by filtering impurities from rain and snowmelt. The crowns of trees serve as filters to trap smoke and dust flowing in the air.

History Book

The lighter spring wood and darker autumn wood of trees that grow in areas with seasonal changes together form annual rings of uneven width that record the life of the tree. Thin rings develop in years of drought, air pollution, and attacks by insects and pests. Thicker rings are a sign of sunny, humid years. Annual rings have even been used to date old wooden buildings and wood-carvings.

Erosion Fighter

Forests shelter land from wind and water erosion, preventing widespread flooding and landslides.

Because of their loose structure, forest soils are up to 30 times more porous than soils in open areas. They can absorb, store, and slowly discharge water from rain and snow-melt, even on steeply sloping lands, without causing damage.

Natural Recycler

In providing a home and rich food source for various forms of animal and plant life, forests constantly recycle their resources. Fungi and bacteria as well as an almost infinite variety of invertebrate animals, live in and exploit the remains of vegetation and animal waste, eventually reducing it to fine humus soils.

Along with waste products, all the minerals that have been absorbed through the roots of living trees and plants used in the building of plant tissues are discarded into the waste-basket of the forest floor and transformed so that they can be absorbed by the roots of other plants.

Ancestral Home

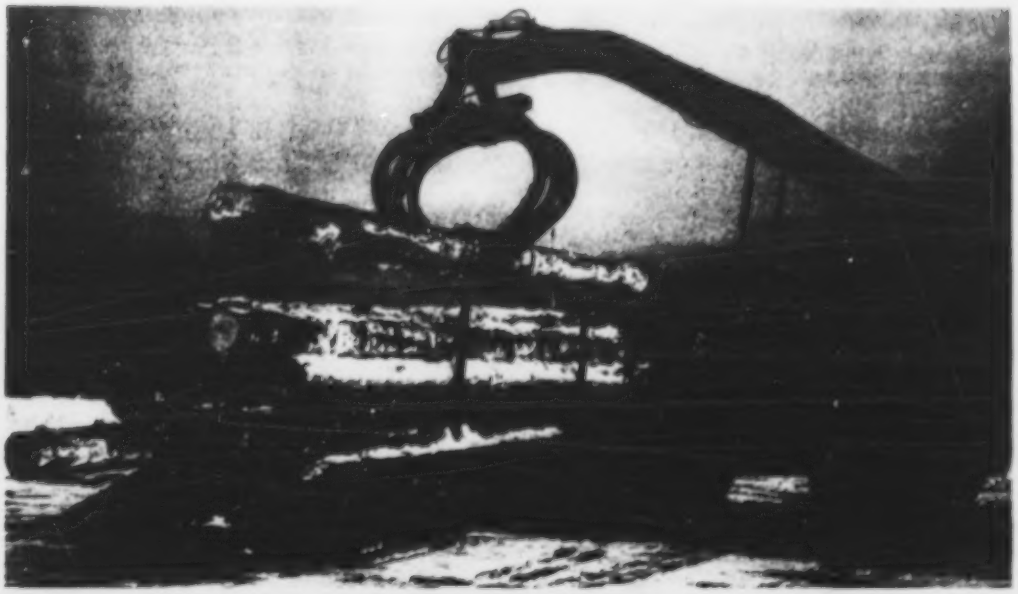
Forests are part of our heritage, the roots of our culture. To Native peoples, forests are more than woodlots. They are part of the land which to them is their life.

In cities, trees conceal industrial complexes and other technological eyesores. They help protect residential areas from noise, particularly in the high-frequency ranges that cause the greatest stress. They shield homes from winter winds, creating mini climates as warm as in areas 500 kilometres to the south.

Gene Bank

Forests serve as gene pools for developing new and better varieties of hybrids. They harbour species of plants and animals that would otherwise disappear and are of inestimable value in the search for new foods, drugs, textiles, and pesticides.

Forests have served as places of recreation for centuries, providing spiritual nourishment and a refuge from the trappings of civilization.



Northern Coniferous Forest

Largest of Manitoba's natural vegetation regions, the Northern Coniferous Forest is also called the boreal forest. It accounts for two-thirds of the province's forested lands.

Species

In the eastern and northern parts of the region, tree cover is dominated by black spruce, jack pine, and tamarack. Jack pine is found on the thin soils of the uplands and black spruce on the poorly drained soils and bogs of the lowlands. Pure stands of jack pine, generally located on flats and ridges, are a legacy of fires.

Mixedwood stands of white spruce, white birch, balsam fir, trembling aspen, and balsam poplar grow along watersheds and south-facing slopes. Manitoba maple, black and green ash, and bur oak are found along the southern margins.

The central and southwestern parts of the region support similar forests, the exception being the Cedar Lake area with its eastern white cedars.

Highly Productive Region

A highly productive region, the Northern Coniferous Forest accounts for 60% of the wood harvested in the province.

Between 1981 and 1985, some 920,000 cubic metres were harvested in the region each year – equivalent to 15,000 rail-cars of logs. This represents about 14% of the annual allowable cut for the region. The annual allowable cut is the amount of wood that can be harvested in a forested area each year on a sustainable basis. Harvesting levels are not expected to increase in the region until the mid 1990s.

Trees are cut for a range of products, including pulp for kraft paper, newsprint, lumber, posts, railway ties, mine timber, and fuelwood.

Harvesting at Pine Falls

The Pine Falls area of the region was the setting for a locally owned sawmill that began operation in the late 1800s. The province's first pulp and paper mill, operated by Abitibi-Price, began production in Pine Falls in 1927. In 1957 the mill was upgraded to its present capacity of 500 tonnes of newsprint a day.

With the exception of 3 years during the Dirty 30s, the forests of Pine Falls have been harvested continuously for nearly a century. Sound forest management has ensured a supply of wood in the past without jeopardizing the needs of the future, and local foresters are determined that the trend will continue.

The Pas Comes On Stream

The forest industry next expanded in 1970, when a new kraft pulpmill began production in The Pas. A sawmill has since been added to produce dimensional lumber. Several other smaller scale sawmills have traditionally operated in the region.

In 1989, Repap, a major Canadian pulp and paper company, bought the Manfor kraft paper mill at The Pas. Repap proposed a major expansion of pulp production by upgrading the mill and developing a second one. The company's planned mill and forest management activities are under review for environmental licensing.

Tree improvement efforts in the region currently focus on selecting and developing genetically superior trees from native species.

Loss of Forested Land

To date, agriculture, mining, roads, hydro reservoirs, and transmission lines have taken up relatively small areas of forested land in the region.

Major developments planned for the 1990s may have a significant impact. Construction of Bipole III, a proposed major high-voltage transmission line, and the road construction associated with expanded harvesting levels, are cases in point.

Acid Rain

Flin Flon and Thompson, the largest cities in the region, are home to mining and smelting complexes that emit large quantities of pollutants. Studies show that loss of sensitive plant species, contamination of surface soils by heavy metals, reduced conifer germination and growth, and other negative effects are generally limited to within 5 kilometres of both complexes, although pollutants have been detected as far as 20 kilometres away. To date, acid rain damage and other long-range effects of airborne pollutants have not been detected in the forests of the region. Monitoring continues, in recognition of potential impacts of emissions on ecosystems in Manitoba and beyond our provincial boundaries.

Duck Mountain winter haul

Repap Fact Sheet

Repap, a leading Canadian pulp and paper company, is proposing to expand operations at the former Manfor pulp and paper mill which it now operates.

The company estimates it will need harvesting rights to 108,000 square kilometres – 20% of Manitoba's land mass and 33% of productive forest land in the province. But before Repap can go ahead, its plans must be approved under The Environment Act, a process that includes public hearings.

Chlorine Bleaching Proposed

In 1989, Repap – "paper" spelled backwards – bought Manfor, a Crown-owned paper mill that now produces 400 tonnes of unbleached kraft paper a day. In Phase I, Repap proposes to convert the mill to a chlorine bleached pulp mill capable of producing 500 tonnes of bleached pulp a day. The bleached pulp (which has the look and texture of white blotting paper) would be shipped to Repap's paper mill in Wisconsin for conversion to glossy paper for magazines and advertising flyers.

In Phase II, Repap plans to build a new mill in The Pas to produce 1,200 tonnes of bleached softwood (spruce, fir, and pine) pulp a day. It also plans to adapt the Phase I upgraded mill to use hardwood (aspen, poplar, and birch) instead of softwood and step up production to 550 tonnes of bleached pulp a day.

Landmark Hearings

In August 1989, the Clean Environment Commission held public hearings to address Phase I conversion of the existing pulp mill. The first hearings ever held for a pulp and paper mill under The Manitoba Environment Act of 1988, they focused on the impacts of dioxins, furans, and other potential pollutants from the bleaching process that would be discharged to the Saskatchewan River.

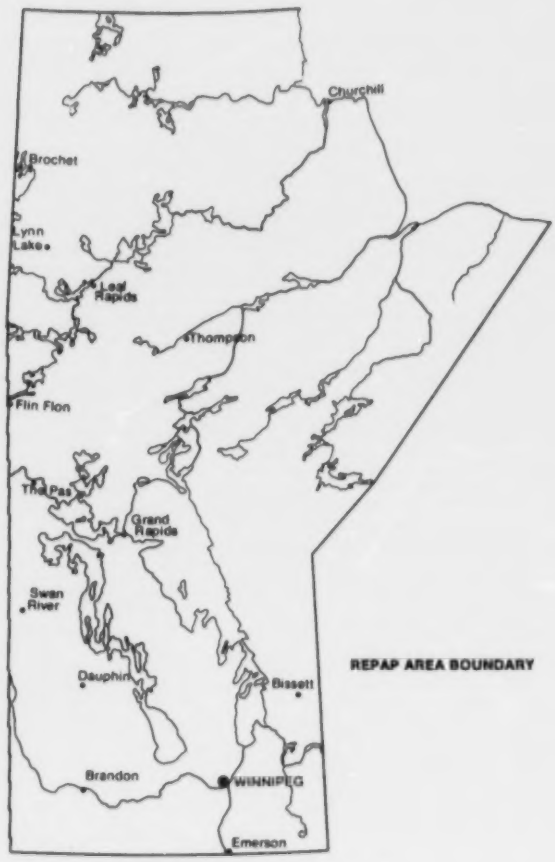
Licence Appealed

In June 1990, Repap was granted an operating licence for Phase I. A month later, the approval was appealed by TREE (Time to Respect Earth's Ecosystems). Repap also appealed the licence because it felt that the monitoring requirements and environmental limits were too stringent.

Phase II Hearings

Repap's Phase II mill proposal and its 5-year operating plan, which outlines planned road building, harvesting, and replanting, are currently undergoing extensive review as part of The Environment Act approvals process. Repap must prepare a detailed environmental impact assessment which will undergo intense public scrutiny through public hearings. This is the first time a private forest company in Manitoba has had to seek environmental approval for its forestry operations.

Issues to be addressed at the hearings include the effects of waste water from chlorine bleaching operations on aquatic life and water quality in the Saskatchewan River. Issues related to the 5-year operating plan include harvesting methods, replanting success, impacts of roads, the need to protect ecosystems and maintain genetic diversity, the impacts of forestry operations on the traditional lifestyles and pursuits of Native peoples, and the commitment of such a large portion of the province's forest resources versus the need to promote recycling to conserve natural resources.



Repap's proposed forest management licence area

Federal Government Joins Process

In 1990, the federal government applied its environmental assessment and review process to screen Repap's proposals.

A decision on the proposals is not expected until the end of 1991. Before a licence is issued, Repap will have to show that wildlife habitat, Native and local use, species diversity, and future harvest can be sustained. It will also have to ensure that its operations meet provincial guidelines on stream crossings, buffers, protection of wildlife habitat, and reforestation of all lands cut. It will be required to apply the latest pollution control technology to new developments, and obtain approval under The Environment Act for any subsequent changes to the mill. The provincial government would be responsible for cleaning up past pollution problems at the former Manfor mill, which had a poor environmental and economic history.

Repap has stated that it will not proceed with any activities until all environmental approvals are received.

Tree seed orchard for developing genetically superior trees

Broadleaf/Mixedwood Region

Some of the province's most productive forests grow here, in the Riding, Duck, and Porcupine mountains. And some of the least productive sites are also found here, in pockets of shallow calcareous soils in the central part.

Twelve provincial forests, covering 30% of the region, help secure the forest land base for the long term viability of the forest industry as well as for recreation and conservation.

Species

The region derives its name from the predominantly mixed deciduous forests it supports. Trembling aspen, the dominant species, grows in pure stands as well as mixed with birch, balsam poplar, or a variety of conifers (cone-bearing trees such as spruce, pine, and fir). Pure stands of conifers are sometimes found in the dry sandy soils of the southeast and central sections as well as on the mountains in the west.

Eastern white cedar is found in the region, small remnant stands of white pine and red pine grow in the southeast corner, and scattered white elms colonize the river courses as far north as Red Deer Lake.

Harvesting

The region accounts for the balance of wood harvested in the province. Rate of use is higher than in the Northern Coniferous Forest – 38% of the annual allowable cut as opposed to 14%.

In some parts, allowable cuts for certain species are almost fully committed, as for example, black spruce and jack pine in the southeast. Demand for these and other hardwood species is expected to increase with development of a particle board plant in Winnipeg and the proposed expansion of Repap's facilities in The Pas.

The region supplies the pulp and paper industry, lumbering, and specialty products such as fence posts, poles, pallet material, logs for log structures, poplar pulpwood, fuelwood, and Christmas trees.

Plantations

The pioneers looked to this region first for wood products to supply the developing towns, cities, and settlements of the province. As a result of its early development, forest management is evident throughout. There are numerous plantations of various age classes, many of which are approaching the age and size appropriate for harvest. Natural and plantation forest stands have been managed through cleaning, thinning, and pruning to foster sound forest growth and development.

New tree species – Scot's pine, Siberian larch, lodgepole pine, and hybrid poplars – have been introduced to the area with varying success. As in the Northern Coniferous Forest, tree improvement currently focuses on selecting and developing genetically superior trees from native species.

Loss of Forest Lands

Large tracts of forested land in the region have been converted to agricultural production, even though the agricultural production that followed often proved marginal. The practice has been discouraged by recent changes in Crown land classifications. Mining, recreation, transmission lines, and roads have also eliminated significant areas of productive forest here.

The impacts of fire, insects, and disease fall within calculated tolerances in the region. Several insects and diseases such as the spruce budworm, jack pine budworm, western gall rust, and armillaria root rot are monitored regularly to determine their impacts.

Grassland

Although the Grassland Region is the wheat belt of the province, it includes ribbons of forest along the major river courses and two provincial forests that cover 1% of the region. Trembling aspen, the dominant species, grows in the small patches of woodland still remaining.

The borders of the region are a transition zone between the boreal forest and native grasslands. If left to nature, the trembling aspen along this forest front would advance rapidly.

Use of the forest resource in the Grassland Region has been minor in recent years but was significant in the early development of the province. Conifer plantations in the Spruce Woods and Turtle Mountain provincial forests have historical significance and are approaching harvesting age.

Landowners with deciduous trees on their properties are increasingly involved in conservation and wildlife habitat enhancement, with the result that small woodlot management is on the increase here.

Winnipeg Region

Natural forests here are similar to those of the Grassland Region. They extend along the corridors of the Red and Assiniboine rivers and in small bluffs protected from development.

In the city, ornamental trees and shrubs make up most of the forest vegetation, interspersed with large blocks of trees on natural land such as the Assiniboine Forest. Winnipeg is known for its excellent boulevard shade tree program and the large number of trees throughout the city. Beaudry, a provincial park just west of the city, boasts a river-bottom forest with towering cottonwoods – some of the biggest trees in the province.

Tree growth and development are encouraged throughout Winnipeg through a relatively large and well supported forestry department. Trees are recognized for their aesthetic values as well as for energy conservation, erosion protection, buffering potential, and the general well-being of the environment.

The city derives economic benefits from the commercial use of forests in other regions. About 20% of the direct and indirect jobs relating to the forest industry occur in the city. This includes the manufacture of wood based products such as roofing materials, wallboard, particle board, furniture, windows and doors, and others.

Concerns in the region include Dutch Elm Disease, loss of forested land to urban development, and loss of natural forested areas, particularly along the rivers. In addition, because the region's forests are mature and over-mature, they are vulnerable to natural stresses such as drought, insects, and disease.

Turtle Mountain plantation

Dutch Elm Disease

Dutch Elm Disease (DED) kills hundreds of elms every year in Manitoba. It is controlled by an extensive program of detection and management which the province put into place in 1975 when DED was first detected here. The program is designed to hold the loss of urban elms to less than 2% a year.

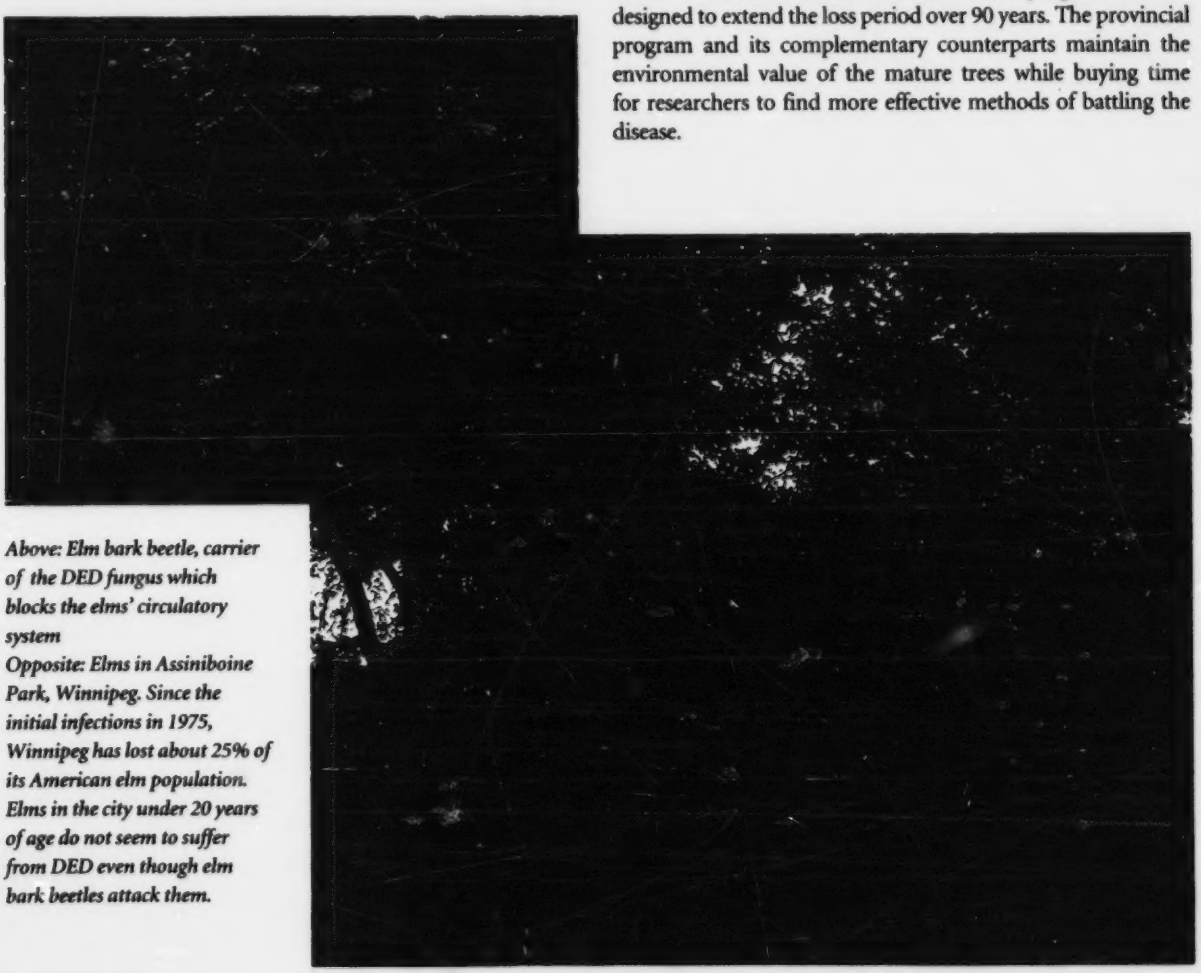
DED is caused by a fungus first identified in Holland. The fungus is spread by elm bark beetles that carry the sticky spores on their bodies when they move from infected elms to feed on healthy ones. Underground root grafting between the trees, elm firewood, diseased logs, and trees that fall in the water and are carried downstream can also spread the disease.

Campers who unknowingly use firewood from diseased elms and take the leftover firewood with them rather than leaving it behind have inadvertently helped spread the disease across North America.

Forty-eight cities, towns, and municipalities participate in the province's DED program, which is implemented by Manitoba Natural Resources. Effort concentrates on urban centres, parks, and buffer zones around towns and cities. Winnipeg's forestry department has developed its own DED program which complements the provincial effort. Programs focus on sanitation, basal spraying for bark beetles, tree pruning, tree injections, and publicity.

Winnipeg has about 250,000 mature elms, with 60,000 on boulevards and the rest in parks, along riverbanks, and on private property. Less than 2% of the city's elms are removed annually because of DED and other environmental stresses. Of these, 85% are cut from the city's wild riverbank population. In terms of programs to combat DED in North America, the provincial program has been one of the most successful.

If the disease were allowed to run its course in Winnipeg, it would kill most of the city's native elms within 10 years. The cost of removing and replacing dead elms over the 10 years would be the same as the cost of the current program which is designed to extend the loss period over 90 years. The provincial program and its complementary counterparts maintain the environmental value of the mature trees while buying time for researchers to find more effective methods of battling the disease.



Above: Elm bark beetle, carrier of the DED fungus which blocks the elms' circulatory system
Opposite: Elms in Assiniboine Park, Winnipeg. Since the initial infections in 1975, Winnipeg has lost about 25% of its American elm population. Elms in the city under 20 years of age do not seem to suffer from DED even though elm bark beetles attack them.

Fire

Fire plays a role – sometimes an indispensable role – in the life of a forest. It is a resource that renews and diversifies.

In the natural forests of the Northern Coniferous Forest and Broadleaf/Mixedwood Forest regions, the dominant trees – jack pine, spruce, and aspen – have evolved as fire-dependent species subject to fires that have been killing stands every 75 to 125 years since the last ice age.

In the grasslands, before the arrival of European settlers, fires caused by lightning or set by Native peoples burned large areas, limiting the intrusion of certain trees species into the prairie landscape. As farming started and expanded, "prairie fires" were fought and controlled because they threatened the new way of life that was developing.

Forest fires continue to be perceived as a threat in areas where people have settled or where the forest has been designated for harvest. Fire prevention and protection programs are given top priority, and fire suppression is an immediate response to this natural lifestage.

This creates problems in the forest. Fire cleanses the forest of litter build-up and helps recycle nutrients and life sustaining compounds. In contrast, forests in developed areas or areas of high fire protection status often become more fire prone due to the build-up of combustible material on the forest floor. Consequently protected forest areas often burn more intensively and affect larger areas than they would if they had been cleansed by fire in the natural course of events.

The Northern Coniferous Forest and the Broadleaf/Mixedwood Forest regions lost extensive areas of forest to fires and insect infestations during the 1980s, particularly in 1989 when about 3,000,000 hectares were burned – a record loss for the province. An estimated 1,147 separate fires were involved, with 627 caused by lightning and 520 by people. Value of timber lost was estimated at $375 million. The cost of suppressing the fires, which forced evacuation of 24,500 people from 32 communities, totalled $68 million.

In the Grassland and Winnipeg regions fire has not been as detrimental.

The Fire Prevention Act addresses fire management on Crown land, land managed by local government districts or rural municipalities, and private lands within a specified distance of wooded districts. The provincial fire protection program applies a combination of 32 lookout towers, six contract high-wing detection aircraft, and a lightning-locator network to detect fires. Better support for fire fighters has been a priority, with $1.5 million added to their budget of $6.6 million in 1990.

Following a fire, loggers have up to 2 years to harvest burned trees before insects destroy the wood.

AREA BURNED IN MANITOBA 1918 – 1990

Source: Manitoba Natural Resources

Insecticides and Herbicides

Forest management has at times implemented practices or treatments that have attracted public criticism, such as the aerial application of insecticides to control insect infestations and the use of herbicides to control undesirable vegetation.

Problems which could arise from such practices range from disruption of natural bio-chemical activities in forest soils or plant systems to destruction of the natural enemies of insects and disease organisms. In addition, herbicides are often perceived as causing major disruptions to natural vegetation systems leading to loss of wildlife and wildlife habitat.

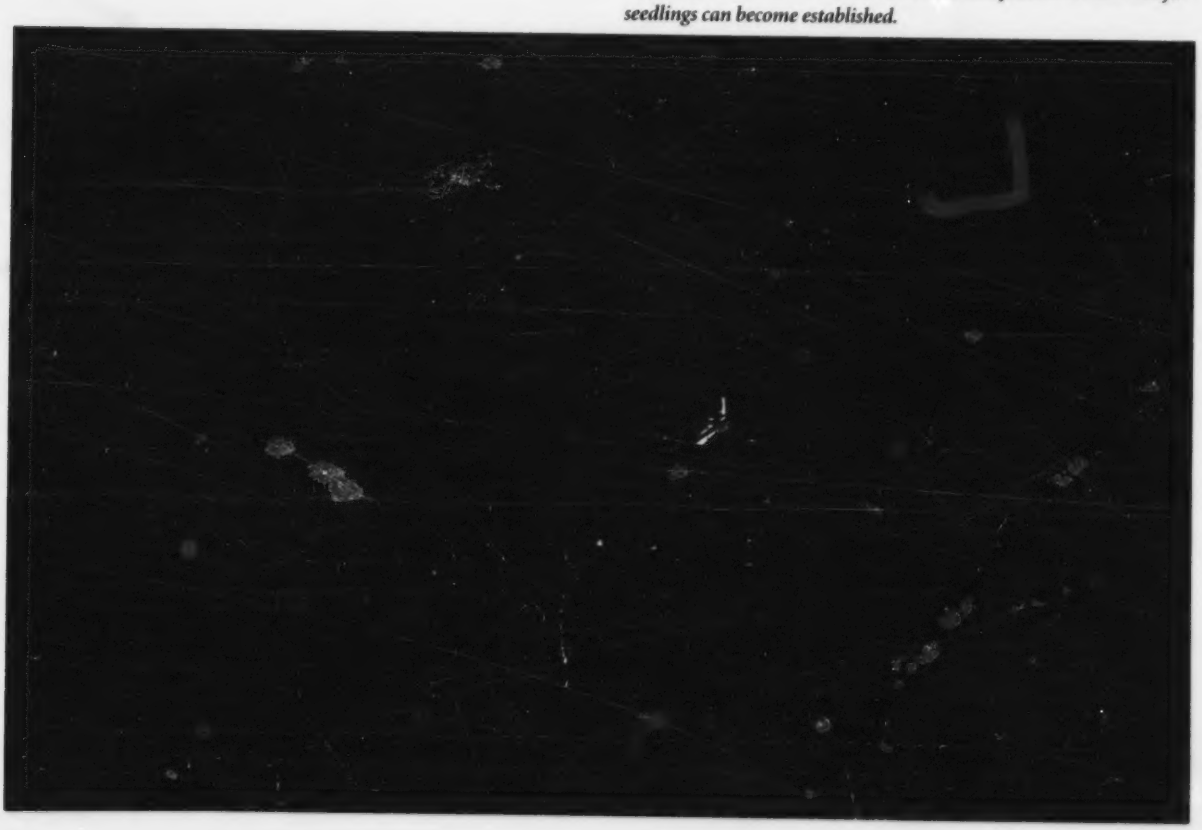
In Manitoba the use of insecticides has been limited to selected, small areas. Forest policies currently restrict insect control programs to applications of benign biological control agents such as *Bacillus thuringiensis* in all regions except Winnipeg. Aerial applications of insecticides are used only as a last resort, and effects are monitored.

The use of herbicides for site preparation and plantation management has also been limited. Between 1981 and 1985, only 1,081 hectares received treatment. Aerial applications initially used 2,4-D, but by 1984 only glyphosate (Vision or Roundup) was used.

Glyphosate, the only herbicide fully registered for aerial application in Canadian forests, underwent extensive testing in Manitoba during the mid 1980s. Tests showed minimal impact on natural biota and wildlife habitat, indicating that glyphosate appears to be an acceptable product in terms of its environmental effects. At present it is aerially applied to about 300 hectares annually. Each use must be registered with Manitoba Environment. Applicators must be licensed and observe strict guidelines.

Soil and vegetation sampling to determine the effectiveness of aerial spraying of glyphosate.

Applying herbicides to control hardwood competition so that conifer seedlings can become established.



Harvesting and Forest Renewal

Commercial extraction of the forest resource has, in the past, been driven by economic considerations. But in the 1980s, public demand for sustainable resource development led to forest use decisions that consider environmental as well as economic principles.

Concerns about overharvesting are often associated with the mistaken belief that logging companies always cut large areas, endangering the genetic characteristics of forest ecosystems and leaving behind a wasteland that will not support further forest growth.

Reforestation of harvested lands is a priority of the Forestry Branch of Manitoba Natural Resources which seeks to ensure that all areas harvested are regenerated within a specified time to standards based on the original composition of species and stands.

About 20% of all harvested areas regenerate naturally, without treatment.

Area Harvested & Regenerated (Hectares)

	1981	1989
Harvested[1]	11,880	12,205
Regenerated[2]	5,865	9,679

1. Estimate based on volume harvested divided by the provincial average volume per hectare of 150 cubic metres.

2. Includes areas planted, seeded, or scarified for natural regeneration.

Source: Manitoba Natural Resources

The 1980s witnessed major advances in forestry legislation and policies to address management concerns. The Forestry Branch implemented a 20-year management plan for the province in 1981. The plan covers forest use, industrial development, road access, monitoring, fire management, forest renewal, and tending programs. Five-year assessments of the status of the forest resource, which were recommended in the 20-year plan, are now a requirement of The Forest Act.

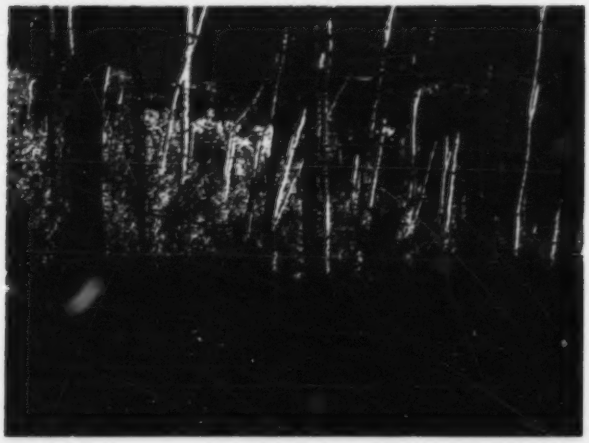
In 1984, a 5-year Canada and Manitoba Forest Renewal Agreement was signed to further advance forest management. Under the agreement, $27.2 million was allocated to the Manitoba Forestry Branch and Forestry Canada. An additional $14.9 million was added from Manitoba's Jobs Fund Sectoral Project in Forestry. At the same time, Abitibi-Price and Manfor spent $7 million on forest renewal projects, bringing the total additional money spent on forest management to $50 million over and above existing provincial operating budgets.

Under the Forest License Agreement with Manfor (now Repap Manitoba) the company is "responsible for renewing all areas harvested to provincial standards (*Provincial Regeneration Stocking Standards*) within a set time period." Abitibi-Price had previously agreed to similar conditions in its 1979 licence. Both companies are responsible for ensuring that their reforestation efforts meet the criteria set out in the provincial standards.

The Forest Renewal Agreement provided funds for research in nursery management, forest genetics, and tree improvement to meet the commitment to full forest renewal. Forest nurseries at Clearwater in The Pas and Pineland in Hadashville were also expanded, with the result that the tree-growing capacity of Manitoba nurseries rocketed from 1 million trees in 1956 to 20 million in 1990. Tree planting programs increased from 3.2 million seedlings in 1981 to 8.9 million in 1985 with about 13.5 million planted in 1989.

The Forest Act and its associated regulations provide the principal tool for sustainable management of our forest resources. They set out harvesting criteria and make provisions for assessments that penalize logging firms who exceed sustainable yield cuts.

Natural regeneration of jackpine following a fire



Containerized seedlings are grown for forest renewal and for sale under the current woodlot program as part of the Forest Renewal Agreement.

Forestry Techniques

Forestry is an excellent example of the relationship between economics and environment. This industry is an essential ingredient of the Manitoba economy; if it is to continue to be, the forests on which it depends must be managed in an environmentally sensitive and sustainable fashion. Here is a brief description of several key forestry techniques which will help to ensure sustainability.

Harvesting Patterns

Many people think that when cutters harvest timber, they cut down everything in sight. In fact, they generally cut trees in strips, blocks, or other patterns, leaving standing trees to provide seed and protection for cut-over areas.

There are cases where all trees – regardless of age – are cut in a large area, sometimes hundreds of hectares. Large-scale clear-cutting of this type is a technique that is sometimes used to eliminate a serious infestation of insects or fungus or when the forest has been seriously damaged by wind, fire, or drought. But in view of the erosion, siltation, damage to fisheries, loss of drinkable water and other environmental consequences, large-scale clear-cutting by harvesters can no longer be justified on economic grounds.

Reforestation

It is a common misconception that harvesting must be followed by tree-for-tree replacement. More times than not, each tree cut is replaced with many more trees – sometimes a hundred or more if the process is left to nature.

The objective of reforestation is to produce a new forest of the highest quality, in the least amount of time, consistent with the limitations of the local climate and soils.

Reforestation usually begins with preparation of the ground to promote the next generation of trees. It involves a range of techniques, from bulldozers equipped with chopper blades to dragging ships' anchor chains across the forest floor to remove surface litter and expose mineral soils for natural regeneration, seeding, or planting nursery seedlings.

An estimated 20% of cleared areas will regenerate on their own, but the process does not usually reproduce merchantable trees quickly. Willow, alder, and hazel sometimes invade the site, forming what foresters refer to as a junk forest. Eventually the forest yields merchantable species that grow to maturity, but the overall process takes longer than if the site had been reforested using good management techniques.

Determining Allowable Cuts

One of the principles of good forest management is that of an annual allowable cut which strikes a balance between the amount of wood harvested and the amount of wood grown. Recent guidelines on stream crossings and wildlife protection have added an environmental dimension to the application of the principle.

Some species of wildlife depend on mature and over-mature forests for habitat. In planning harvesting patterns, foresters make allowances for these species by leaving at least some mature and over-mature stands alone in each region.

Based on the species of tree, type of soils, and age of the trees in a particular area of forest, foresters can accurately predict how many cubic metres of wood, or cords of wood, will be produced on a hectare of land in a given year and use that figure to determine the annual allowable cut for the year. Foresters can also predict when a tree, or stand, will reach maturity – the best time to harvest it.

Left to nature, a forest that reaches maturity enters a stage of degeneration where growth and activity decrease. The forest gradually settles into a stage of over-maturity where it stays – often for decades – until a natural disaster such as a fire, infestation of insects or disease, or major windstorm sweeps through the forest, ending the stage and ushering in a period of renewal.

Foresters eliminate or compress the over-maturity stage and speed progress toward renewal by determining when the forest has reached maturity and is ready for harvest.

High-Grading – Taking the Best, Leaving the Rest

High-grading means cutting down only the biggest and best trees in the forest, or certain types or species of trees without regard for associated species. The former process continues in isolated locations in Canada, although newly introduced legislation, sparked by public pressure, has largely put an end to it. The latter process is being considered for certain forest areas previously considered of low value.

High-grading was first used in the early 1800s when European immigrants to Canada began harvesting white pine and oak in the forests of eastern Canada. These trees were large, straight-grained, readily accessible, and prized in Europe where their wood was used to support the shipping industry, particularly white pine which was said to make the best masts in the world.

As the high-grading of white pine and oak continued, lumbermen moved farther afield in search of these species, in keeping with the dictum that there were "always more over the next hillside."

By the early 1900s, supplies of white pine and oak finally ran out. Lumbermen then turned their attention to the spruce, jack pine, and balsam fir that remained in the forest. They started cutting these species to feed the pulp and paper mills that began appearing in small communities and towns across the country in the 1920s.

In the meantime, technology had come to the lumbering industry. The lumberman with his axe and horse working in winter – one of the best systems for harvesting with minimum damage to the forest – was replaced with large machines like the "feller forwarders" that weigh up to 50 tonnes and can damage soils and non-merchantable trees left behind.

By the early to mid 70s, after more than 150 years of high-grading in Canada, it became increasingly clear that the forest industry was in serious trouble. The cost of operations had dramatically increased as the last of the forest resources were exploited in areas close to the mills. In the absence of reforestation, lumbermen had to travel up to 150 kilometres or more to find trees, for marginal returns.

Today, lumbermen are proposing to high-grade trembling aspen and poplar – once considered undesirable "weed" species, with rapid rates of regeneration – as feedstock for new mills to be built in the 1990s.

Greater public awareness of the importance of our forest resources has focused attention on harvesting practices and led to developments that are expected to safeguard our forests.

In the 1980s, largely as a result of a public outcry, governments began to pay more attention to the management of forests as a national resource. In Manitoba, an agreement between the federal and provincial governments funded research into genetically improved trees, production of forest nursery stock, and development of forest protection programs to address the neglect of forest lands during the preceding decades.

In 1990, draft policies for managing the province's forests were released for public consultation and feedback (*see* **Sustainable Development**).

The pulp and paper industry and other major forest users are now required to obtain environmental licences, a process that ensures sustainable use of the forest resource.

Protecting Our Forests

Conservation Programs

On January 31, 1990, Manitoba released a draft workbook on a sustainable development strategy for forests. Following public review and cabinet approval the province will have established the first such forest strategy in Canada. Forest policies adopted in this strategy should ensure that all future forest development will be environmentally and economically sound.

Provincial forests have been established throughout the province as one of the earliest forest conservation practices to ensure the long-term viability of our forests. The statutory purpose of the provincial forests is "to reserve certain areas in the province for a perpetual growth of timber, and to preserve the forest cover thereon, and to provide for a reasonable use of all the resources that the forest lands contain." They covered 1.95 million hectares in 1960, an area which was expanded in the mid 80s to the present coverage of 2.5 million hectares.

In those provincial parks where forest harvesting is allowed, parks are zoned in closed, restricted, and open areas. Manitoba allows forest harvesting in most of its provincial parks, in keeping with the multiple-use concept.

In the late 1980s, Manitoba Natural Resources developed guidelines for protecting stream crossings and wildlife habitat. The guidelines were prompted by concerns about road construction, clear-cutting, and other forest harvesting operations that could threaten fish and wildlife.

Volunteer Programs

The Manitoba Forestry Association offers educational programs at the elementary level on fire management and forest conservation. It operates a conservation and interpretive centre at Hadashville, and recently opened three more centres, in the Duck Mountains, Clearwater Lake, and near Fisher Branch. Forest conservation is also promoted by the Boy Scouts of Canada, mainly through their *Trees for Canada* planting program.

Educational Programs

National Forest Week, during the second week in May, features public displays and free seedlings.

The Forestry Branch produces *The Tree Line,* a series of pamphlets on insect and disease problems in the province, and demonstration notes on other forest related topics. The Branch circulates *Treevia,* a forestry quizz game, to schools throughout the province to stimulate interest in forestry and Canada's forest heritage.

Heritage Trees of Manitoba, organized in 1985 by the Manitoba Forestry Association, promotes forest conservation by identifying the most significant trees and groves of trees in the province. According to the Association, the largest tree in the province is a 35-metre high cottonwood, with a circumference of 638 centimetres, growing just southwest of Portage la Prairie.

Manitoba Natural Resources, Forestry Canada, the forest industry, and conservation groups offer educational programs that promote forest management activities in the province.

Forest Strategy

In keeping with the province's committment to sustainable development, the Land and Water Strategy includes forestry as the third resource to be addressed. The proposed policies to guide the management of our forests went through a series of public workshops in spring of 1990, and the responses received during those workshops are being incorporated into the final version of a forest strategy.

Trends

Fire protection ——— **Better**
Sophisticated computer techniques, more provincial water bombers, better access to fire-fighting equipment in other provinces, and new lightning detection systems combine to give Manitoba world-class fire-fighting capability.

Reforestation ——— **Better**
Nursery capacity, as well as number of trees planted and grown, are at an all-time high.

Dutch Elm Disease control ——— **Better**
This trend reflects continued financial support for tree replacement, more areas treated, more surveillance, and more public cooperation in protection of healthy trees.

Legislation and regulation ——— **Better**
Laws for forest protection and renewal, tougher penalties for enforcement, and public involvement in drafting policies for the sustainable development of our forestry resources are at an all-time high.

Harvesting pressure ——— **Worse**
Annual harvesting levels are up, fuelled by demand world-wide.

Provincial forests ——— **Better**
Total area of provincial forests increased from 1.95 million hectares in 1960 to 2.5 million hectares in 1987.

WILDLIFE

Manitoba's diversity of natural regions makes it unusual among Canadian provinces. Its environment is a blend of tundra and taiga, boreal and mixedwood forests, parkland and prairie. These regions generate a corresponding diversity of wildlife – over 400 species of commonly occurring birds, mammals, amphibians, and reptiles. Manitoba's environmental health is reflected in the abundance and variety of this resource.

Volunteers helping relocate white-tailed deer

A Regional Look at Wildlife

Northern Transition/Tundra

Although there are relatively few species of wildlife in the Northern Transition/Tundra region, they often receive more international attention than Manitoba's other wildlife because of their unique nature or spectacular abundance.

Thousands of snow geese nest at La Perouse Bay, east of Churchill. Dozens of species of Arctic birds including the Lapland longspur, Smith's longspur, lesser golden-plover, semipalmated plover, and whimbrel breed along the Hudson Bay lowlands. A relatively stable population of polar bears wanders the Hudson Bay coast. Herds of barren-ground caribou migrate across the borders with the Northwest Territories and Saskatchewan. Beluga whales, possibly the world's greatest concentration, frequent the mouths of the Nelson, Churchill, and Seal rivers. Small numbers of harbour seals, and occasionally bearded seals, are found at the mouths of the Churchill, Hayes, and Nelson. Harbour seals may occur up to 160 kilometres upstream on the Seal.

Northern Coniferous Forest

This region boasts an even more diverse range of wildlife species than the Northern Transition/Tundra.

Much of this diversity is concealed by the difficulty of overland travel. Manitoba's Provincial Bird, the great gray owl, is a resident of the area. Spruce and ruffed grouse are common, and wood warblers and many other songbirds fill the forest in summer. The forest is home to small herds of woodland caribou. Moose are common along lakes and streams and in areas recently burned or logged.

The Saskeram and Summerberry marshes with small boreal forest waterbodies, provide important habitat for furbearers and waterfowl. Mink, marten, fisher, otter, and beaver are common and extremely important to the economy and culture of northern communities. Diving ducks are the predominant waterfowl, with dabbling ducks abundant in some locations.

Broadleaf/Mixedwood Forest

This region, with its frequent meadow openings, is home to many wildlife species that live on the boundaries of forests and grasslands. White-tailed deer and ruffed grouse are found throughout the region, as well as great horned owls, sharp-tailed grouse, northern goshawks, moose, elk, black bears, and snowshoe hares.

The climate is mild enough for red-sided garter snakes to flourish in some locations. Muskrats and beavers thrive in the wetlands.

Grassland

A wide variety of natural grasslands once occurred in this region of southern Manitoba and covered more than 10% of the province. Many species found in the Broadleaf/

Mixedwood Forest, such as white-tailed deer and sharp-tailed grouse, also live here. Species well-adapted to grasslands, such as the gray (Hungarian) partridge, northern harrier, prairie songbirds, and white-tailed jackrabbit, are found in the region. Reptiles and amphibians include the red-sided garter snake, western hognose snake, tiger salamander, and plains spadefoot toad.

Manitoba's only true lizard, the northern prairie skink, is found in Spruce Woods Provincial Heritage Park and the Lauder Sandhills Wildlife Management Area. Badgers, coyotes, and weasels are fairly common furbearers. Dabbling and diving ducks are common in wetlands of the Minnedosa pothole country and in the Delta and Netley-Libau marshes.

Winnipeg

The city hosts a range of wildlife species. Raccoons are common along river banks, and songbirds are abundant in parks, along waterways, and at back yard feeders.

Fort Whyte Centre for Environmental Education is frequented by waterfowl and white-tailed deer.

More than 500 white-tailed deer live in the city, primarily in the Assiniboine Forest. Such a concentration of wildlife mean numerous viewing opportunities, but the animals also cause automobile accidents. From 1985 to 1988, 283 deer were moved from the city to suitable sites in southern Manitoba, primarily around St. Malo.

The wetlands of Manitoba's Broadleaf/Mixedwood and Grassland regions are among the most productive ecosystems in the world. As permanent water storage basins, they recharge groundwater supplies, minimize flooding, and retain water in times of drought. They provide a setting for recreation and are a source of food, water for livestock, and income from trapping and guiding. Yet wetlands have been disappearing at an alarming rate. They are drained to boost agricultural production and accommodate large machinery. Hydroelectric development has flooded vast wetland complexes, and residential and industrial developments take their toll through drainage schemes, landfill projects, and pollution. But there is hope for the future, with cooperative programs between landowners, government, and private conservation agencies to preserve and enhance Manitoba's wetlands heritage.

Hunting and Trapping

Hunting and trapping are the primary consumptive uses of wildlife. Manitobans harvest and consume roughly 2 million kilograms of wildlife annually.

Harvesting

Over the past 10 years, the harvest of ducks in Manitoba has dropped from 400,000 to 200,000 as the availability of ducks declines and fewer hunters go in the field. The annual harvest of geese has remained stable at around 175,000.

The annual harvest of big game animals has remained relatively steady at 30,000 animals, which includes about 25,000 white-tailed deer. Licensed hunters annually harvest about 1,200 moose, 300 elk, 20 barren-ground caribou, and 60 to 70 woodland caribou.

The black bear harvest has tapered off after a slow increase. The yearly harvest of bears is between 800 and 1,000 by resident hunters, 700 by nonresident hunters, and 400 by trappers.

Between 160 and 250 wolves are harvested annually: 100 are trapped, 10 to 50 are hunted, and 50 to 100 are removed as problem animals.

Harvests taken by upland game bird hunters and Treaty Indians are poorly known.

Harvests of furbearers vary annually depending on pelt prices, weather, environmental disturbances, and the cyclic nature of some furbearer populations. Pelt values for coyote, fox, lynx, racoon, and other long-haired species fell during the 1980s. Market demand for fisher, marten, and mink remained strong, resulting in stable or slightly lower prices.

Extremely high pelt values during the late 1970s and early 80s put tremedous trapping pressures on some species. This, combined with low reproductive rates and population cycles, reduced populations of lynx and fisher.

Harvesting of northern leopard frogs, tiger salamanders, and red-sided garter snakes is controlled by permits. Snakes and frogs are sold for the pet trade, university research, and classroom projects. Salamanders are harvested for bait in sport fishing.

Numbers of northern leopard frogs tend to fluctuate on a 7- or 10-year cycle. The highest recorded weight harvested was 50,000 kilograms in 1972 and the lowest, 1,300 kilograms in 1985. No frogs were harvested between 1976 and 1982 because of low numbers resulting from red leg, a symptom of kidney disfunction that causes blood to concentrate in the legs of frogs.

Numbers of tiger salamanders captured are generally low. In 1989, only 40 kilograms were sold.

Numbers of red-sided garter snakes harvested ranged from 23,000 in 1979 to 90,000 in 1985. In 1989, a moratorium was placed on the harvest because of concern over population numbers.

There is no licensed harvesting of marine mammals inside provincial boundaries. Polar bears and belugas are occasionally captured for zoos and aquariums.

Trapping Seasons

Trapping seasons are set provincially, in consultation with the Manitoba Trappers Association, to ensure a sustainable harvest. Seasons are based on population levels and the reproductive capabilities of the species.

Manitoba Natural Resources monitors the age, sex, and other biological characteristics of the furbearer population using carcasses collected from trappers. When the data shows that the population is dropping, as in the case of cyclic species, the department introduces quota systems to regulate the harvest and ensure recovery.

The Registered Trapline System was implemented in the 1940s to manage the fur harvest. Today there are 42 trapping districts in the northern, central, and eastern portions of the province. Under this system, which has proven very successful,

Hunting and Trapping Licences, 1984 to 1990

	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
			Numbers of Licences (x 1,000)			
HUNTING						
Game Bird	38.7	35.3	38.6	38.9	36.5	35.0
Big Game	59.4	52.5	53.5	58.6	58.8	57.6
Wildlife Certificates	68.2	62.6	64.6	66.8	64.0	61.7
TRAPPING						
Open	12.6	11.7	12.1	11.5	7.6	6.4
Registered Traplines	2.9	3.0	2.7	2.9	2.5	2.2
			Value of Licence ($ x 1,000)			
Hunting	2,034.3	2,065.1	2,215.8	2,420.7	2,328.7	2,551.2
Trapping	33.9	32.4	87.5	86.5	63.0	54.0

Source: Manitoba Wildlife Branch

Prince Albert of Monaco and Chief Larry Catagas of the Waterhen Band dedicate the wood bison project to the memory of Princess Grace of Monaco. Band members are raising the bison to establish a wild herd.

traplines are assigned to individual trappers or registered blocks are assigned to a community. Trappers and communities are expected to manage the harvest of all furbearers in their areas to ensure sustained production.

Agro-Manitoba, which covers the southern third of the province, operates as an open area where no one has exclusive trapping rights. Parts of the open area are designated as special trapping areas under which trapping pressure is controlled by special permits.

Annual earnings of trappers in the province generally total between $500,000 and $10,000,000. Earnings dropped from $8,000,000 in 1986/87 to $2,400,000 in 1988/89, and have been projected at $1,500,000 for 1989/90 because of a market surplus of coyote, mink, and other furs, and lobbying by anti-trapping and animal rights groups. When prices are low, some trappers do not operate their traplines.

Hunting Quotas

Manitoba Natural Resources tries to keep populations of all wildlife species at the highest level possible while maximizing harvesting and viewing opportunities and minimizing the damage that wildlife cause. Where there is not enough game for hunters, Manitoba Natural Resources holds draws and may issue one licence to two people to take only one animal between them. Where there is plenty of game, as in remote areas, general licences allow each hunter to take one animal.

For deer, moose, and elk, harvest levels are based on population estimates determined from such indicators as hunter success rates, aerial surveys, observer programs, and simulation models. Harvest levels for waterfowl are based on harvest success, whether the harvest or number of hunters is increasing or decreasing, limits in the United States, habitat conditions, and wintering-ground counts.

Bear population estimates are based on population density field studies done elsewhere in North America and applied to Manitoba. Licences for bears are issued on the assumption that the provincial population can withstand the hunting pressure of one animal for each hunter. Harvestable surplus beyond those taken by residents are given to non-resident hunters.

Because nonresident big game hunting has grown dramatically in recent years, Manitoba Natural Resources has licensed lodges, outfitters, and guides to better control the nonresident harvest of black bears and moose. Each is allocated a quota of licences that limit the number of clients each year. Quotas are set for each game hunting area based on harvestable surplus after resident harvest.

By 1989, nearly 30 lodges and 105 outfitters were licensed. These businesses sold 1,285 nonresident big game hunting packages, generating more than $2 million for Manitoba, much of which benefited rural businesses and employment.

Native Hunting and Management of Big Game

Treaty Indians have always hunted big game without restriction. They are, and always have been, within their rights to do so, but the tradition has raised hackles, particularly among recreational hunters and resource managers concerned about local shortages of game.

In the early 1980s, in a continuing effort to better conserve and manage the province's big game, staff from Manitoba Wildlife started working with Indian bands to manage moose, barren-ground caribou, woodland caribou, elk, and other big game species in several areas of Manitoba. Here are some of the programs currently under way:

Pukatawagan. The Mathias Colomb Indian Band is taking part in preliminary discussions toward cooperatively managing wildlife, fish, and forests on its reserve in northeastern Manitoba.

Beverly and Kaminuriak Caribou Management Board. Indians and government personnel from Manitoba, Saskatchewan, and the Northwest Territories, with federal government staff, have formed this board to make recommendations on the management of barren-ground caribou as well as on exploration, nonresident hunting, and other activities that could affect the herds.

Game Hunting Area 8 Moose Management Board. Three Indian bands and residents of The Pas, with government staff, are managing the moose populations in Game Hunting Area 8. The Indians voluntarily agreed to stop hunting in the area for 3 years, and the area was also closed to licensed hunting to allow populations to recover. In 1990, the Indians agreed to set an upper limit on the number of moose they took and to share the resource with licensed hunters.

Viewing and Other Non-Consumptive Uses

Viewing, photography, scientific studies, and habitat enhancement are among the non-consumptive uses of wildlife. Trends in the sale of natural history materials and supplies such as bird feeders show that this use of wildlife is extensive and growing.

In a 1987 survey, nearly 85% of Manitobans reported that maintaining abundant wildlife and preserving endangered species were important activities. The survey showed that Manitobans spend a lot of time and money on non-consumptive activities: of those interviewed, 88% said they watched films or read about wildlife; visited zoos, game farms, aquariums, or natural history museums; and maintained, improved, or bought wildlife areas. Sixty-nine percent spent an average of 60 days a year feeding, watching, photographing, or studying wildlife around their homes or cottages. In the same year, Manitobans spent just over $500 per capita on non-consumptive, wildlife-related trips.

In 1989, 83,000 people visited Oak Hammock Marsh, 15,000 visited the Cape Churchill Wildlife Management Area, and 7,089 visited the Narcisse snake pits.

Threats to Wildlife

Dabbling ducks, once found in massive numbers in southern Manitoba, numbered 3,000,000 in 1958. Land use practices, drought, and hunting have cut duck populations to an all-time low of 600,000 in 1984.

Manitoba's snake city. One of the largest, if not the largest, concentrations of garter snakes in the world is the Narcisse snake hibernaculum in the Interlake. More than a quarter of a million snakes are thought to spend the winter here in limestone sinkholes known as hibernacula.

Loss of habitat is a serious problem for white-tailed deer, waterfowl, and elk. For white-tailed deer and waterfowl, the problem is mainly the conversion of their habitat to farmland. In southwestern Manitoba, wooded cover that provides habitat for game birds, white-tailed deer, and entire songbird communities is shrinking at the rate of up to 7% a year. Loss of habitat thins out the fauna of a region and slows their recovery. Without "islands" of habitat, recolonization is very unlikely, with the result that there are fewer species.

Wetland habitat is lost to agriculture, urbanization, and the rights-of-way for highways and associated drainage ditches, reducing nesting success and fall populations of waterfowl. In southern Manitoba, more than 70% of wetlands have now been lost.

Moose and elk habitats are being affected by fire control measures that have become increasingly efficient in recent years. As forests mature, they offer fewer of the plant species that moose and elk need for good nutrition. Clearing for farming is another factor in the destruction of elk habitat.

Moose have also been affected by disease, ticks, winter weather, unregulated hunting, and predation.

Severe winter weather increases mortality and reduces productivity. Drought lowers the quality and quantity of food that deer need, leaving them to face winter in poor condition. It can also dry out normally wet areas, making it easier for hunters to reach the animals.

Unregulated hunting, predation by wolves and black bears, disease, and severe winter weather are key factors in reducing populations of elk and woodland caribou. Forestry practices, such as road construction and logging, can decrease woodland caribou numbers because of greater harvest through increased access and loss of the mature forest habitat where woodland caribou thrive.

Exploration actitivites can disturb calving grounds and migration routes, and wildfire can destroy habitat, causing a decline in barren-ground caribou populations.

Because black bears prefer mature forests, their numbers decline following wildfire and clear-cutting, but populations tend to recover with the return of the forests. Dry years reduce food supplies for bears, affecting the reproductive success of females by lowering their body fat.

Furbearers are affected by mange, rabies, and other density-dependent diseases, wildfire, trapping pressure, and habitat disturbances caused by hydroelectric, forestry, agricultural, and mining practices.

For upland game birds, major concerns are the loss of cover and nesting habitat to drought, agriculture, and forestry; loss of food supplies to drought, chemical applications, and forestry; chemical build-up in the food chain; and low survival of young resulting from a combination of these factors.

Because birds of prey are protected, it is illegal to have them in your possession without a permit.

Poaching

Poaching in Manitoba is the illegal taking of fish, game, and timber. Meat and antlers - not hides - are the major reasons for poaching deer, moose, or elk.

Teeth to Timber

Antlers are used in folk medicine and as aphrodisiacs. Many parts of black bears are sold, particularly gall bladders (to make aphrodisiacs), teeth, and claws. Birds of prey are popular, with feathers, eggs, and live birds bringing top prices. Poachers favour pickerel and sturgeon, which command the highest prices. Timber harvesters commit a form of poaching if they harvest timber without authorization or sell more than specified in a quota or permit.

Poaching is normally "policed" through routine departmental enforcement patrols by district Natural Resources Officers. Recent years have seen the introduction of several new enforcement programs.

T.I.P.

In 1985, Natural Resources set up The Turn In Poachers (T.I.P.) hotline, the first if its kind in Canada. Callers do not have to identify themselves, although it is helpful if the case comes to trial. About one-quarter of the calls lead to prosecution.

Undercover Work

In 1987, the department organized a Special Investigation Unit of Natural Resources Officers who work undercover to break up poaching networks. They go after poachers of fish and game in the province's larger urban centres based on information from investigations, calls from the public, and the T.I.P hotline. They have successfully infiltrated several fish poaching rings, mainly in the Interlake.

In the fall of 1990, the department set up a decoy program to catch poachers in the act of illegally bagging deer or moose.

Hard to Catch

Despite these efforts, poaching continues to flourish in certain areas of the province. Poachers can often get away because they know the area well. When they are apprehended and the case comes to trial, poachers frequently get off on a technicality.

Special Rights

Poaching does not apply to Treaty Indians who have the right to hunt or fish for food at all times of the year, by any means, on unoccupied Crown land where they have right of access, or on private land where they have been granted permission by the landowner. They are not allowed to sell fish, meat, hides, and antlers of any big game taken under these special rights.

Habitat Havens

The status of wildlife is enhanced or protected by five types of specially designated areas with suitable, vulnerable or unique habitat.

Provincial and National Parks represent areas of special significance for wildlife. Atikaki Provincial Wilderness Park and Riding Mountain National Park are examples of valuable habitat for wildlife.

Ecological Reserves provide stringent protection for representative portions of ecosystems and represent areas of special significance to wildlife.

Wildlife Management Areas are parcels of Crown land designated specifically for managing wildlife and wildlife habitat.

Wildlife, Game Bird, Goose, Special Canada Goose, and Furbearing Animal Refuges provide special protection for wildlife, as well as people and property where the discharge of firearms poses a risk.

Special Conservation Areas protect rare or endangered species.

Provincial and National Parks

Name, Type of Park	Hectares
Northern Coniferous Forest	
Atikaki Wilderness Park	406,539
Clearwater Lake Natural Park	49,572
Grass River Natural Park	228,963
Nopiming Natural Park	143,749
Paint Lake Recreational Park	22,643
Broadleaf/Mixedwood Forest	
Duck Mountain Natural Park	127,472
Elk Island Heritage Park	1,001
Grand Beach Natural Park	2,461
Grindstone Point Recreational Park	25,822
Hecla Natural Park	86,353
Moose Lake Recreational Park	957
Whiteshell Natural Park	273,512
Grassland	
Asessippi Natural Park	2,461
Beaudry Heritage Park	881
Birds Hill Natural Park	3,523
Spruce Woods Heritage Park	24,865
Turtle Mountain Natural Park	18,908
Provincial total	**1,431,667**
Riding Mountain National Park	297,604
Total hectares	**1,729,271**

Ecological Reserves

Name, Purpose	Hectares
Northern Transition/Tundra	
Baralzon Lake	39,000
undisturbed low arctic aquatic ecosystems and plants representative of high arctic ecosystems near the southern limits of their natural range	
Northern Coniferous Forest	
Islands of Kaweenakumik Lake	20
large concentration of colonial nesting birds such as the white pelican	
Long Point	1,600
beach ridges and bogs containing a stand of mature white cedar at the northwestern fringe of its range	
Red Rock	485
beach ridge supporting white spruce and reported to contain the most northerly stand of Bur Oak in Manitoba	
Reindeer Island	14,200
wide variety of Boreal Forest plant communities ranging from mixed upland forest to open black spruce forest and bog	
Broadleaf/Mixedwood Forest	
Brokenhead	66
typical mixed wood river bottom forest	
Cowan Bog	518
typical spruce bog and associated lake ecosystems; seven species of wild orchids	
Lewis Bog	453
undisturbed fen with rare wild orchids	
Libau Bog	186
black spruce and tamarack bog and floating sedge bog with a wide variety of wild orchids	
Pocock Lake	162
bog lake, beach ridge and gradation of plant communities from moisture tolerant to drought tolerant	
Wampum	62
mixed deciduous/coniferous forest containing mature red pine	
Whitemouth River	130
mixed deciduous/coniferous forest with distinct lowland and riverbank species	
Total hectares	**56,882**

Wildlife Management Areas

Area	Purpose/Target Species	Hectare
	Northern Transition/Tundra	
Cape Churchill	polar bears, geese	1,885,659
Cape Tatnam	polar bears, caribou	524,390
	Northern Coniferous Forest	
Saskeram	waterfowl, fur, moose	96,299
Tom Lamb	waterfowl, fur, moose	215,415
	Broadleaf/Mixedwood Forest	
Alonsa	deer, grouse	10,602
Basket Lake	moose, elk	7,220
Broad Valley	deer, grouse	3,382
Catfish Creek	general	6,309
Cayer	deer, grouse	1,528
Clematis	deer, grouse	5,236
Dog Lake	ducks, colonial birds	32,520
Grahamdale	deer, grouse	1,496
Gypsumville	moose	2,476
Harperville	deer, grouse	650
Hilbre	waterfowl, grouse	1,266
Inwood	deer, grouse	2,276
Langruth	deer, grouse	1,789
Lee Lake	moose, waterfowl	6,994
Little Birch	moose, elk, deer	21,984
Lundar	elk, deer, grouse	1,106
Mantagao Lake	moose, elk, deer	50,543
Moose Creek	moose	79,268
Moosehorn	waterfowl, deer	195
Narcisse	deer, grouse, snakes	11,885
Onanole	deer, moose, elk	585
Parkland	deer, moose, elk	911
Peonan Point	deer, waterfowl	2,350
Point River	deer, grouse	3,382
Proulx Lake	deer, waterfowl	3,317
Rembrandt	deer	1,236
Sandridge	deer, grouse	1,230
Sharpewood	deer, grouse	1,821
Sleeve Lake	waterfowl, elk, deer	15,024
Steeprock	moose, deer, grouse	1,899
Thalberg Bush	moose	715
W. P. Davidson	moose, deer, grouse	5,854
Washow Bay	waterfowl	1,398
Weiden	deer, grouse	846
Westlake	deer, grouse	5,760
	Grassland	
Assiniboine Corridor	deer, grouse	3,312
Bernice	deer	65
Brandon Hills	deer, recreational use	727
Broomhill	grouse	325
C. Stuart Stevenson	deer, grouse	130

Deerwood	deer, erosion control	224
Ebor	deer, grouse	65
Gerald W. Malaher	deer, grouse	60
Grants Lake	waterfowl, furbearers	405
Holmfield	ducks, deer, grouse	65
Lauder Sandhills	deer, grouse	3,146
Little Saskatchewan River	grouse	260
Maple Lake	waterfowl	65
Marshy Point	waterfowl	1,496
Oak Hammock Marsh	waterfowl	3,528
Otter Lake	waterfowl	65
Pembina Valley	deer, grouse, waterfowl	2,230
Pierson	deer, grouse	260
Portage Sandhills	deer, grouse	1,333
Proven Lake	waterfowl	1,987
Rat River	waterfowl	1,008
St. Malo	deer, grouse	173
Souris River Bend	deer, grouse	2,084
Spruce Woods	elk, moose, deer	293
Tiger Hills	deer, grouse	356
Turtle Mountain	deer, moose, grouse	260
Upper Assiniboine	deer, grouse	1,860
Wakopa	deer, grouse	65
Wellington	deer	65
Whitemud Watershed	deer, grouse	4,911
Whitewater Lake	waterfowl	9,082
Total hectares		**3,045,437**

Wildlife, Game Bird, Goose, Special Canada Goose, and Furbearing Animal Refuges

Name	Purpose	Hectares
	Northern Coniferous Forest	
Chief G. Barker	big game/safety	road refuge [1]
	Broadleaf/Mixedwood Forest	
Big Grass Marsh	waterfowl	16,960
Buffalo Point	big game/safety	road refuge
Dog Lake Islands	geese	583
Duck Mountain	big game/safety	road refuge
Hecla Island	big game/safety	14,974
Jackfish Lake	waterfowl	1,489
Lee Lake	waterfowl	1,554
Netley Marsh	waterfowl	1,072
Pointe du Bois	game birds	389
Red Deer Point	waterfowl	9,013
Red Pine	furbearers	453
Reykjavik	geese	2,590
Sleeve Lake	geese	3,885
Swan Pelican	big game/safety	road refuge
Waterhen	wood bison	2,392
Whiteshell	waterfowl/safety	64,490
	Grassland	
A. Enns	wildlife oasis	< 25
Birds Hill	safety	654
C. D. Falk	wildlife oasis	< 25
Carman	safety	1,271
Delta	waterfowl/safety	1,916
E. Bergman	wildlife oasis	< 25
E. M. Halstead	wildlife oasis	< 25
Fort Whyte	safety	932
G. C. Froese	wildlife oasis	< 25
G. L. Froese	wildlife oasis	< 25
Grants Lake	waterfowl	583
H. Klassen	wildlife oasis	< 25
Harry Cox	general	32
J. D. Penner	wildlife oasis	< 25
J. Hooge	wildlife oasis	< 25
J. Unrau	wildlife oasis	< 25
John McPhail	general	32
Lynchs Point	safety	259
M. Penner	wildlife oasis	< 25
Marshy Point	game bird	389
Marshy Point	geese	15,110
Minnedosa Lake	safety	1,878
N. Eidse	wildlife oasis	< 25
Noel Ham	wildlife oasis	< 25
Oak Lake	waterfowl	2,469
Oak Lake	waterfowl	23,960
Rock Lake	waterfowl	1,841
Ropenheim Coulee	wildlife oasis	< 25
St. Ambroise	safety	358
St. Charles	safety	5,010
Spruce Woods	general	8,665
Swan Lake	waterfowl	9,324
Tobacco Creek	wildlife oasis	< 25
W. Sessions	wildlife oasis	< 25
West Shoal Lake	waterfowl	11,140
Total hectares (approximate)		**206,067**

[1] Road refuges generally cover an area 300 metres each side from the centre line.

Special Conservation Areas

Name	Purpose	Hectares
	Northern Transition/Tundra	
Churchill	Ross' gulls	32,375
	Northern Coniferous Forest	
Walter Cook	piping plovers	< 25
	Broadleaf/Mixedwood Forest	
Clandeboye Bay	piping plovers	< 25
Total hectares (approximate)		**32,425**

Source: Manitoba Natural Resources

Baralzon Lake Ecological Reserve in the Northern Transition/Tundra Region. The reserve is known for its arctic ecosystems which are at the southern limit of their range.

Saving Wildlife and Wildlife Habitat

Programs that protect, preserve, or create habitat represent critical support for wildlife. Some programs involve joint efforts with agencies from outside the province and even outside Canada. Here is a cross-section of representative habitat-related projects and programs that apply to Manitoba.

North American Waterfowl Management Plan (NAWMP)

The major wetlands management program is NAWMP, an agreement signed in 1986 between Canada and the United States to rebuild waterfowl populations to levels of the 1970s.

Both countries recognize the current problem – low population levels of mallards and pintails in the prairie provinces and states, primarily because of a decline in the habitat base. Both countries accept that solutions are needed, and recognize that rebuilding the habitat base to achieve population goals could cost an estimated $1.5 billion. The program is cost-shared with 75% from the United States and 25% from Canada. The provincial and federal governments are each contributing 10% and Ducks Unlimited Canada, Wildlife Habitat Canada, and North American Wildlife Fund are supplying 5%.

About $1 billion has been targeted for the Canadian prairies. Manitoba has developed a program that calls for the expenditure of $134 million over a 15-year period to rebuild breeding populations of mallards, pintails, and other ducks. The program features intensive habitat development through land use changes designed to benefit farming as well as waterfowl production throughout Agro-Manitoba.

Loss of prey species reduces wolf numbers while the expansion of agriculture northwards subtracts from their range. In the 1940s, 50s, and 60s, wolf control programs were part of wildlife management. But new approaches disallowed widespread population control and put an end to this practice. Wolf populations have recovered provincially since the 60s.

Cone basket nesting site. Placed by landowners, the baskets are made of wire mesh and filled with flax which resists decay. The baskets attract Canada geese and mallards because they provide a firm nest foundation from which the young can go directly to the water.

Habitat Enhancement Land Use Program (HELP) is a part of NAWMP. Under HELP, farmers are paid to set aside land for wildlife and soil and water conservation. A joint venture of Manitoba Natural Resources, Wildlife Habitat Canada, and Ducks Unlimited Canada, HELP is a $3-million, 8-year program aimed at protecting the province's declining waterfowl and wildlife populations while promoting sound land use practices. The program began in 1988 with the rural municipality of Shoal Lake as the setting for the first projects, which included converting farmland to natural grassland, rotational grazing pastures, and salinity planting patches.

Heritage Marsh Program

Manitoba's Heritage Marsh Program was set up in 1985 to designate, conserve, manage, and develop some of the province's most significant marshes.

Candidate sites must harbour a diversity of wildlife and offer important recreational, economic, or educational benefits.

Today, the partnership involves the provincial Wildlife Branch, Ducks Unlimited Canada, the Manitoba Naturalists Society, the Manitoba Wildlife Federation, and Wildlife Habitat Canada.

Oak Hammock Marsh Wildlife Management Area captures the lush, wild character of a marsh teeming with wildlife. Its marshlands, grasslands, and lure crops support over 260 kinds of birds, 25 species of mammals, and scores of smaller animals. Other heritage marshes include Summerberry, Delta, and Lidcliff marshes.

A depredation prevention program is built into all heritage marsh developments to prevent or reduce crop damage by waterfowl.

Oak Hammock Marsh, perhaps the best known wildlife management area in the province, is a stopover for as many as 400,000 geese during spring and fall migration. The setting also serves as an outdoor classroom for conservation education. Manitoba is part of the Mississippi flyway for North American waterfowl.

Critical Wildlife Habitat Program

This program involves land acquisition, habitat protection agreements with landowners, and habitat enhancement projects. It is cost-shared by Manitoba Natural Resources, Wildlife Habitat Canada, Manitoba Habitat Heritage Corporation, World Wildlife Fund Canada, and the Manitoba Naturalists Society.

The Tall-Grass Prairie/Prairie Conservation Strategy, a component of the Critical Wildlife Habitat Program, seeks to preserve Manitoba's tall-grass prairie sites by acquiring or leasing sites from interested landowners.

Conservation Corridor Program

Focusing primarily in southwestern Manitoba, this program is dedicated to preserving unused municipal road allowances in their natural state.

Under Ribbons of Habitat, a component of the corridor program, permanent tree, shrub, and grass cover is maintained or restored along unused road allowances to cut erosion, slow spring runoff, as well as improve subsoil moisture, wildlife habitat, and recreational opportunities.

Farming for Tomorrow

Many kilometres of shelterbelts are now being planted in rural Manitoba by farmers, through programs led by soil and water associations, that will improve wildlife habitat. Activities of Ducks Unlimited Canada, Manitoba Natural Resources, and Manitoba Agriculture are promoting the expansion of land under permanent cover in cooperation with Manitoba farmers.

Forest Management Guidelines for Wildlife

Forestry, Wildlife, and the forest industry have collaborated in the preparation of guidelines for managing forestry operations in ways that improve "living conditions" for wildlife (*see* **Forests**).

General guidelines cover the location of access roads, design of cutting areas, timing of cuts, and planting practices. Under species guidelines, for example, cutters are to limit the size of cutting blocks to 8 hectares in areas with white-tailed deer, and spare blocks of mature cover to accommodate nesting great grey owls.

Volunteer Programs

Several wildlife programs benefit from the contributions and work of volunteers and private organizations.

Oak Hammock Marsh interpretive programs use volunteer interpreters and visitor services attendants throughout the summer. A Cooperative Deer Monitoring Program on the south side of Riding Mountain National Park involves 150 residents who report on the location and numbers of white-tailed deer during the fall. Rural residents have for years recorded information on snow depths for the Wildlife Branch.

The Wildlife Conservation Awards Committee, Habitat Heritage Corporation Board of Directors, and local wildlife management boards are all staffed by volunteers.

For programs such as the Emergency Deer Feeding Program and the Winnipeg Deer Relocation Program, volunteers are essential and always come forward in large numbers. In many cases, volunteers are members of organizations such as the Manitoba Wildlife Federation and the Manitoba Naturalists Society.

Educational Programs

The Wildlife Branch's primary educational program is Project WILD, which trains teachers to integrate environmental and ecological topics into regular school curricula. Project WILD activities are often prompted by events in the news, such as oil spills, and encourage students to follow through with further endeavours, such as habitat improvement projects on public or private land.

The Wildlife Branch also offers a trapper education program where staff visit schools to deliver presentations on trapping and wild fur management.

During National Wildlife Week, in April each year, the Wildlife Branch and its many cooperating groups conduct a major program to bring wildlife into the public eye. Displays are set up in malls in Winnipeg and rural centres, information is provided to schools, and material is distributed through the mass media.

Manitoba Natural Resources conducts public seminars on topics ranging from moose biology to steel shot.

Mani-Pacs is a school program for grades 5 and 6 where students earn cards for completing wildlife projects. The program, started in 1984, involves roughly 15,000 children.

MINET, which stands for Manitoba Information Network, is sponsored by Manitoba Education and Training to encourage students to use computers by presenting environmental information on line. Over 50% of the schools in Manitoba are linked to this electro-library which accesses more than a million facts on fauna and flora.

Problem Plants and Animals

Another source of stress on wildlife habitat and wildlife is the introduction of new plant species. If conditions are right, non-native plants can multiply without competition and may aggressively crowd out the native vegetation required by wildlife. If the new plants have no food or cover value, they can cut back on wildlife production by eliminating habitat.

Purple loosestrife and leafy spurge top the list of troublesome weeds in this category. They were introduced to North America from Europe in the 1860s. Purple loosestrife spread quickly, reaching Manitoba by 1896, with leafy spurge following in 1913. Within the last 3 years purple loosestrife has infested all major waterways. Leafy spurge has taken over 47,000 hectares.

Purple loosestrife is a wetland plant found in pockets throughout southern Manitoba, especially along the Assiniboine River and in the Cypress River and Rosendale areas. It can quickly take over open water and destroy feeding and nesting sites of waterfowl. Deer, muskrats, and other foragers ignore mature loosestrife because it is tough and woody. As they eat around it, they effectively eat themselves out of their home range by clearing more room for loosestrife to take hold.

Leafy spurge has taken over waste lands, ditches, pastures, and grasslands in central Manitoba and added another threat to the survival of native prairie. It destroys wildlife habitat by outgrowing preferred food and cover plants.

Problem non-native plants are controlled under The Noxious Weeds Act (*see* **Agriculture**). Research to find inexpensive, long-term management techniques to control problem non-native plants are now being developed under laboratory and field conditions by Ducks Unlimited Canada, the University of Manitoba, Dow Chemicals, and the United States Department of Agriculture.

Water manipulation, herbicides, and biological control using insects are being examined as possible methods of managing purple loosestrife. The black dot flea beetle (*Aphthona nigriscutis*), imported from Europe, is being studied as a biological control for leafy spurge. Public educational programs that help people recognize leafy spurge and purple loosestrife, may be the biggest factor in halting the spread of these killer weeds.

Maintaining healthy wildlife populations sometimes carries a penalty. Waterfowl, elk, deer, and black bear, for example, can eat and trample crops, contaminate registered seed crops, and damage fences and beehives.

Manitoba Natural Resources and Agriculture have developed programs to prevent such damage and partially compensate landowners when damage occurs. These programs spread the financial burden of maintaining healthy wildlife populations throughout the province, rather than force landowners to shoulder a disproportionately large part. In Natural Resources, these programs typically require $650,000 annually. Canada shares the cost of programs relating to waterfowl.

The dramatic increase in size and distribution of cormorant colonies has caused local problems for anglers in small lakes stocked with fish. In addition, cormorants have been considered by many to be responsible for the decline in the walleye fishery on Lake Winnipegosis. Figures suggest that cormorants eat few walleye and prey more on fish that eat young walleye, but the controversy continues.

Polar bears can be a serious problem in Churchill and other northern areas where they have been known to kill people and destroy property. The Wildlife Branch has set up a prevention program to discourage confrontations between people and bears and to save the lives of the bears.

Legislation and Regulation

Here are four acts of special significance to our wildlife:

- The Wildlife Act
- The Endangered Species Act
- The Ecological Reserves Act
- The Provincial Park Lands Act

The Wildlife Act defines the animals that fall within its jurisdiction and covers offences relating to hunting, trapping and transporting wildlife. It also covers wildlife in captivity, importing and exporting wildlife, and protection of habitat.

The Endangered Species Act designates, by Order-in-Council, plants, animals, and other organisms as endangered, threatened or extinct. It provides for their protection, for the establishment of an Endangered Species Advisory Committee, and for entering into agreements to restore populations of endangered species. It also defines offences regarding protection of endangered species.

The Ecological Reserves Act provides for the establishment of a system of rigorously protected ecological reserves as examples of typical ecosystems, to help protect rare and unique ecosystems, to assist in the protection of rare and endangered plants, and to help maintain Manitoba's diversity of plants and animals. It allows for establishment of ecological reserves and an Ecological Reserves Advisory Committee and defines offences.

The Provincial Park Lands Act provides for the designation, preservation, management, and maintenance of park lands (*see* **Special Areas**).

Trends

Annual licensed harvest of big game animals ——— **Same**
Annual harvest has held fairly steady at 30,000 animals.

Unregulated hunting ——— **Same**
Unregulated hunting continues to claim unknown numbers of wildlife, adding to the difficulty of managing the resource.

Dabbling duck breeding populations ——— **Worse**
Drought, hunting, and land-use practices have reduced breeding populations in southern Manitoba.

Habitat programs for wildlife ——— **Better**
Canada and the United States have signed the North American Waterfowl Management Plan, a major wetlands management agreement that features intensive habitat development to rebuild waterfowl populations.

Volunteer programs ——— **Better**
People are becoming increasingly aware of wildlife and the need to conserve ideal habitat. They are spearheading or lending a hand with interpretive programs, wildlife monitoring, emergency feeding, and relocation projects.

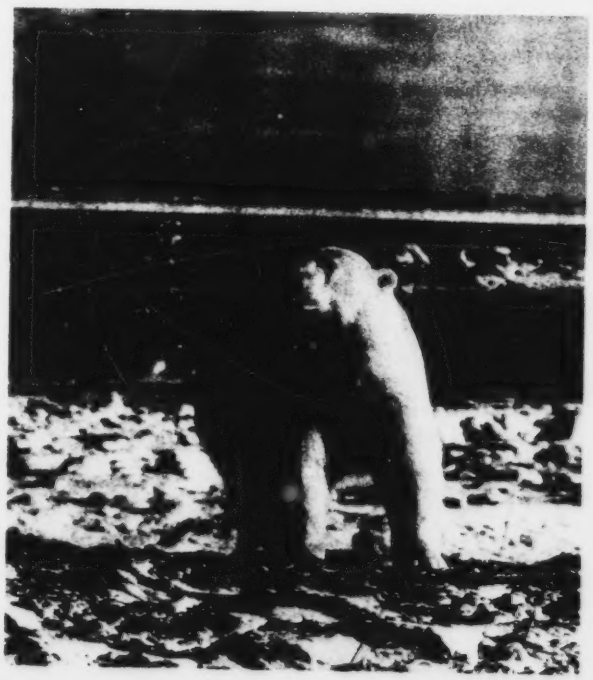
The Polar Bear – A Conservation Success

There are only about 20,000 wild polar bears in the world, with Manitoba's population estimated at 1,000. Thanks to conservation measures in Canada, the United States, and other nations, the population of the animals is now increasing.

Recovery of depleted populations is expected to be slow because bears usually have only two young per year and do not breed until they are four or more years old.

To protect the province's polar bear habitat, particularly prime denning sites, Manitoba has designated more than 5,000 square kilometres of coastal area due east of York Factory as the Cape Tatnam Wildlife Management Area, and another 1,900 square kilometres east of Churchill as the Cape Churchill Wildlife Management Area.

There is no licensed hunting season for polar bears in Manitoba.



FISH

Manitoba's lakes, streams, and rivers support more than 90 species of fish, from walleye, whitefish, and goldeye to rainbow trout, smallmouth bass, and the banded killifish. Our largest fish is the lake sturgeon, weighing in at 23 kilograms and measuring about 2 metres long. The smallest is the tadpole madtom, less than 10 centimetres long.

Fish are vulnerable to a variety of threats, from land uses that ruin spawning sites by coating them with silt and clay particles, to animal wastes and agricultural chemicals that promote algae blooms capable of strangling fish by using up valuable oxygen in the water. Even other fish and shellfish can present a problem. In Manitoba, rainbow smelts could undermine whitefish and walleye fisheries in Lake Winnipeg.

Fish of Manitoba

Walleye (or pickerel), prized by both commercial and sport anglers, is found in all regions of Manitoba except the extreme north. Sauger, a slightly smaller fish of the perch family, often shares the same waters with walleye. Yellow perch, another relative, is more prolific and gaining importance in the commercial fishing industry.

Lake whitefish, the backbone of the commercial fishing industry in Manitoba, favours the cooler or deeper waters of the province. Another closely related species, the cisco or lake herring, is often found with whitefish but is less important commercially.

Northern pike, one of the most sought after of Manitoba's trophy fish, is found in almost all waters. Muskellunge, the only close relative of the pike found in Manitoba, occurs rarely in the southeastern portion of the province and in a few stocked lakes.

Goldeye and mooneye are found in the turbid southern waters of Manitoba - primarily the drainages of the Red, Assiniboine, Winnipeg, and Saskatchewan rivers.

White sucker, the most common species of suckers found in Manitoba, is probably one of our most widely ranging and abundant fish. Other species of suckers include quillback, longnose, silver redhorse, and shorthead redhorse, all with a more limited range.

Smallmouth bass is an important sport species because of its excellent fighting qualities, reproduction rates, and taste. Other members of the sunfish family such as rock bass and black crappie, which also occur in the southern portion of the province, are gaining popularity among sport anglers.

Burbot or maria, a member of the cod family, is found throughout the province, preferring large, deep lakes with water temperatures below 18.5°C.

The freshwater drum ranges throughout the drainages of the Red and Assiniboine rivers in the south and the Nelson River in the north. Known locally as silver bass, sheepshead, and Red River bass, the fish produces a drumming sound by moving the muscles connected to its swim bladder.

The channel catfish is the largest member of the catfish family in Manitoba. The most productive locations are the Red and Assiniboine rivers and the creeks that form the delta of the Red River. The black and the brown bullhead, also members of the catfish family, are confined to drainages of the Red and Assiniboine rivers and occasionally interbreed. The tadpole madtom and the stonecat make up the rest of the catfish family in Manitoba. The madtom is a small black fish under 10 centimetres in length; the stonecat rarely exceeds 30 centimetres.

The lake sturgeon is unique among fish in Manitoba with its large size, long nose, tube-like mouth, and armour-plated skin. The species was once plentiful in Lake Winnipeg and the Nelson, Winnipeg, Red, and Assiniboine rivers. Sturgeon Creek in the west end of Winnipeg was named after the sturgeon that once spawned there.

Brook trout is found in the Churchill, Knife, Seal, God's, Nelson, and other world-famous fishing waters of the north. Today, because of stocking, brook trout can be found in many lakes and streams from Flin Flon south to the United States border.

Lake trout occurs naturally in many of Manitoba's precambrian lakes and in some sedimentary lakes. Its range has been extended slightly by stocking.

Arctic char can be found in the lower reaches of the Seal, Knife, Caribou, and Churchill rivers. The species rarely gets as far south as the Nelson.

Arctic grayling is found in the Owl, Deer, Cochrane, Silcox, Seal, and Wolverine rivers and other northern waters.

Rare and Exotic Fish

There are no endangered fish species in Manitoba, although several species are rare because the province represents the extreme limits of their natural ranges. These include the banded killifish in the Red River at Emerson and the northern brook lamprey in the Whitemouth River near Elma in southeast Manitoba.

Lake sturgeon, a heritage species, has disappeared from the Grassland Region, with only a few populations surviving, mainly in Sipiwesk Lake, lower Nelson River, and Nutimik Lake. Brook trout, another heritage species, could soon disappear from the mainstem Nelson River. Its habitat continues to be lost to hydroelectric development. Under the *Manitoba Fisheries Strategy*, lake sturgeon and brook trout are the only heritage fish named so far. They are native Manitoba species that are not rare at the present time but are endangered by on-going developments.

Exotic fish established in Manitoba since 1880 include rainbow trout, smallmouth bass, white bass, and carp.

Rainbow trout, a member of the family of Pacific salmon, is native to the Pacific coast drainage system, from Mexico to Alaska. Rainbows were first stocked in West Hawk Lake in the Whiteshell in 1945 and today can be found in streams, lakes, gravel pits, and reservoirs across Manitoba. Except for self-sustaining populations in Pine River and Beaver Creek, rainbows must be continuously stocked to maintain populations. They form the major species used in fish farming.

White bass also migrated from the United States, moving down the Red River into Lake Winnipeg. They are now an important sport fish in the Red River.

Carp, which are native to Asia and some parts of Europe, were brought to Manitoba in the late 1880s in an unsuccessful stocking attempt. They were first recorded in the Red River at Lockport in 1939, having migrated downstream from the United States. Since then, carp have spread to many areas of southern Manitoba, principally the Red and Assiniboine rivers and Lakes Winnipeg, Manitoba, and Winnipegosis.

Accidental introductions of goldfish and deliberate introductions of largemouth bass and kokanee have failed to establish self-sustaining populations. Largemouth bass and kokanee are occasionally stocked for sport fishing.

Brown trout, which originate from western Europe and Asia, are stocked in several lakes and streams in Manitoba for sport fishing. We do not have self-sustaining populations because of a lack of suitable spawning habitat.

Fishing for Food, Sport, and Employment

Manitoba's fish are a shared resource. In most lakes and rivers, sport fishermen are the sole users. Commercial and domestic fishermen harvest fish from the larger lakes and some smaller lakes in the north. In the south, bait fisheries depend on small fish species.

Commercial Fishing

Commercial fishing has been an important economic activity in Manitoba since the late 1800s. Although originally confined to Lakes Winnipeg, Manitoba, and Winnipegosis, the industry spread north with expanded rail and road services.

Today, about 3,800 Manitobans earn their living at commercial fishing, primarily in lakes of the Northern Coniferous Forest and the Broadleaf/Mixedwood Forest regions. Each year about 1,800 fishermen are licensed and about 2,000 people are hired to help set and lift nets or handle, process, and market the catch.

Revenue annually generated by commercial fishing is more than $35 million. Fishermen grossed a high of $18.8 million in 1984/85. Income from processing and marketing annually averages $16.5 million.

Walleye and sauger bring the highest prices, with catches of walleye valued at $13 million in 1987, and of sauger $7 million in 1988. The total landed value of the 1987/88 commercial catch was $28 million.

Commercial harvests have ranged from a low of 7.5 million kilograms in 1970/71 to nearly 18 million kilograms during 1940 to 1945 and 1979/80. Since 1980, the catch has levelled off at about 15 million kilograms a year. Between 80% and 90% of the fish caught are exported to markets outside Canada.

Domestic Fishing

Domestic fishing is an important source of food for people living in remote areas of Manitoba. In 1989, 478 permits were issued for domestic fishing, mostly to Treaty Indians.

A domestic harvesting survey conducted in 1985 by the Treaty and Aboriginal Rights Research Centre in Manitoba showed that Treaty Indians need 0.9 million kilograms of fish each year. Other domestic fishermen are thought to need far less fish because they are not as dependent on fish as a food source.

Bait Fishing

Bait fishing has proved locally important to commercial fishermen since the early 1970s. Emerald shiners, primarily from Lake Winnipeg and its tributaries, top the list of popular bait fish. In 1986, 48 bait fishermen landed 100,000 kilograms of bait fish.

Sport Fishing

In 1985, sport anglers harvested an estimated 4,400,000 kilograms of fish. In the 1989/90 sport season, 174,990 anglers bought licences, 44% of which were conservation licences. Some 15 to 20% of the sport fishing went on in the Winnipeg and Red river systems.

Anglers who live outside Canada, or who use commercial facilities such as sport fishing lodges, support the commercial sport fishing industry. There are 121 lodges, 42 outfitters, and 126 outcamps in Manitoba that cater to sport fishermen.

Reclaiming Dauphin Lake

Dauphin Lake once supported a thriving commercial and sport fishery. The lake was regarded as one of the most productive in Manitoba for walleye and other valuable species.

In recent years, environmental pressures caused by erosion, siltation, and nutrient overloading, combined with too many fishermen chasing too few fish, reduced the fishery to a fraction of its former size. Catches of walleye decreased from 91,000 kilograms in 1951 to less than 11,000 in 1986.

Team Effort

Several organizations have taken steps to restore the fishery. The Fisheries Branch imposed quotas on sport and commercial fishing of walleye to give populations a chance to recover, but allowed more harvesting of pike, carp, and other secondary species to reduce competition. The Manitoba Habitat Heritage Corporation, with the Fisheries Branch, built a series of pool and riffle structures to cut erosion and improve spawning habitat for walleye in Mink Creek and the Wilson River. In 1988, the Turtle River Watershed Conservation District, with help from provincial grants, spent nearly half a million dollars on soil and water related programs to address erosion and sedimentation. Over the past several years, the Federal Department of Fisheries and Oceans has stocked more than 50 million walleye fry in Dauphin Lake. Other steps include replanting riparian zone vegetation and building flow controls.

On the Mend

These measures appear to be working. A census of newly hatched walleye larvae in 1990 revealed the highest production since monitoring began in 1983. Commercial fishermen are catching their reduced limit of walleye and successfully harvesting secondary species to supplement their incomes. Sport fishing in the Valley River and other tributaries of Dauphin Lake was excellent in 1990, for the first time in several years.

Perch Fisheries – Making the Most of the Resource

In recent years, the Sport and Commercial Section of the Fisheries Branch has set up programs for 77-millimetre (3-inch) mesh net mid-winter fisheries on Lakes Winnipegosis and Manitoba.

Perch are not easy to catch in the larger mesh nets used during other seasons. The programs give commercial fishermen a chance to harvest perch using smaller mesh nets that have little effect on other species. Perch fisheries are an important source of income for commercial fishermen, particularly when stocks and prices of traditional species are low.

On Lake Winnipegosis in 1990, during the second season of the 77-millimetre mesh mid-winter fishery on the lake, commercial fishermen caught 90,000 kilograms of perch, earning $170,000. The fishery was suspended in March 1990 because levels of blackspot, a parasite, were greater than the federal standard of less than 20 cysts per 37 kilograms of fillets. The parasite does not affect people but appears in the fillet as black sand-like grains that look unpalatable.

On Lake Manitoba in 1990, the 77-millimetre mesh mid-winter fishery produced 245,857 kilograms of perch, 389,429 kilograms of sauger, and 92,907 kilograms of walleye, generating an additional $1.3 million for fishermen.

Because of concerns by anglers and some commercial fishermen that the 77-millimetre mesh net fishery could hurt stocks of walleye and sauger, the Sport and Commercial Section is developing a Lake Manitoba Fisheries Management Plan that considers the interests of all user groups.

Mink Creek was a major walleye spawning stream for Dauphin Lake until widening and straightening of the channel in the 1950s destroyed streambed habitat, causing a critical decline in walleye populations in the lake. Fisheries personnel placed piles of rocks at 70- to 80-metre intervals in the stream to simulate rapids and pools that favour walleye spawning.

Threats to Fish

Fish habitat for valuable species can suffer in areas where agriculture, urbanization, hydroelectric development, flood control, or mining take precedence. Land clearing, drainage works, and agricultural activities tend to increase nutrient, sediment, and pesticide loading in rivers and lakes, poisoning fish and suffocating them by using up oxygen.

In northern Manitoba, water diversion and control projects for producing hydroelectricity have spoiled aquatic ecosystems and caused mercury to be released from the soil. Liquid effluent, tailings, and atmospheric deposition from mining and smelting activities have released contaminants that find their way into lakes and streams. Stream crossings by pipelines and roads have caused erosion and blocked fish passage.

Land Use

Land clearing for agriculture, ditching, drainage, and other land-use practices often mean fish losses. Sediment washed off stream bottoms, stream banks, and farm fields can build up along stream beds and on lake bottoms, cover suitable fish spawning sites, suffocate incubating fish eggs and aquatic food sources, and interfere with the gills of fish. Lake quality for recreation and tourism also suffers.

Channelization involves enlarging, clearing, and straightening stream channels. The practice encourages erosion, leading to the destruction of natural spawning habitat and ultimately, fewer species, fewer fish, and less biota diversity. Channelized streams are often marked by rapid runoff in springtime, wide temperature swings during spawning, summer temperatures too high for most fish, and winterkill. They rarely benefit the food that fish eat, and may even cause a shift in fish species. Flows can flush away incubating eggs or damage spawning habitat by scouring the bottom of the channel.

Rehabilitation of spawning and rearing sites often involves flushing fine sediments from silted-over spawning and nursery areas. Habitat in channelized rivers can be enhanced by adding boulders, logs, and brush to form rapids, pools, riffles, and other hiding places for fry.

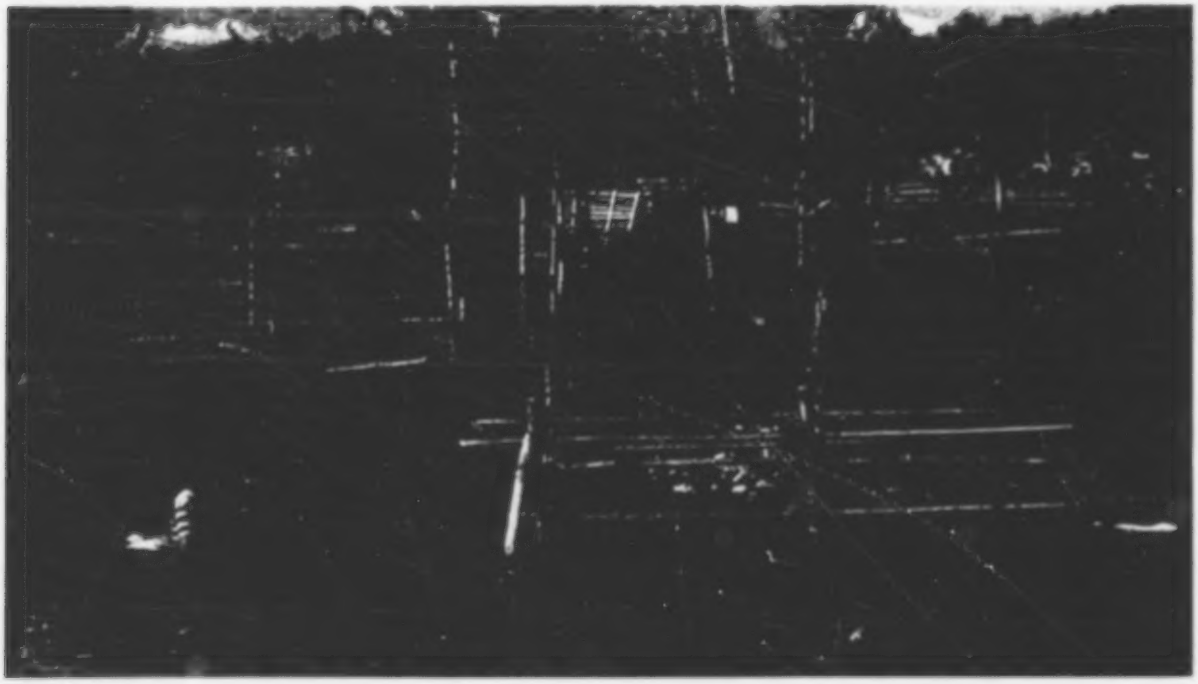
Fish habitat protection and development measures are part of regional resource and land use plans. They often take the form of natural designs for agricultural drains and stream-bank stabilization.

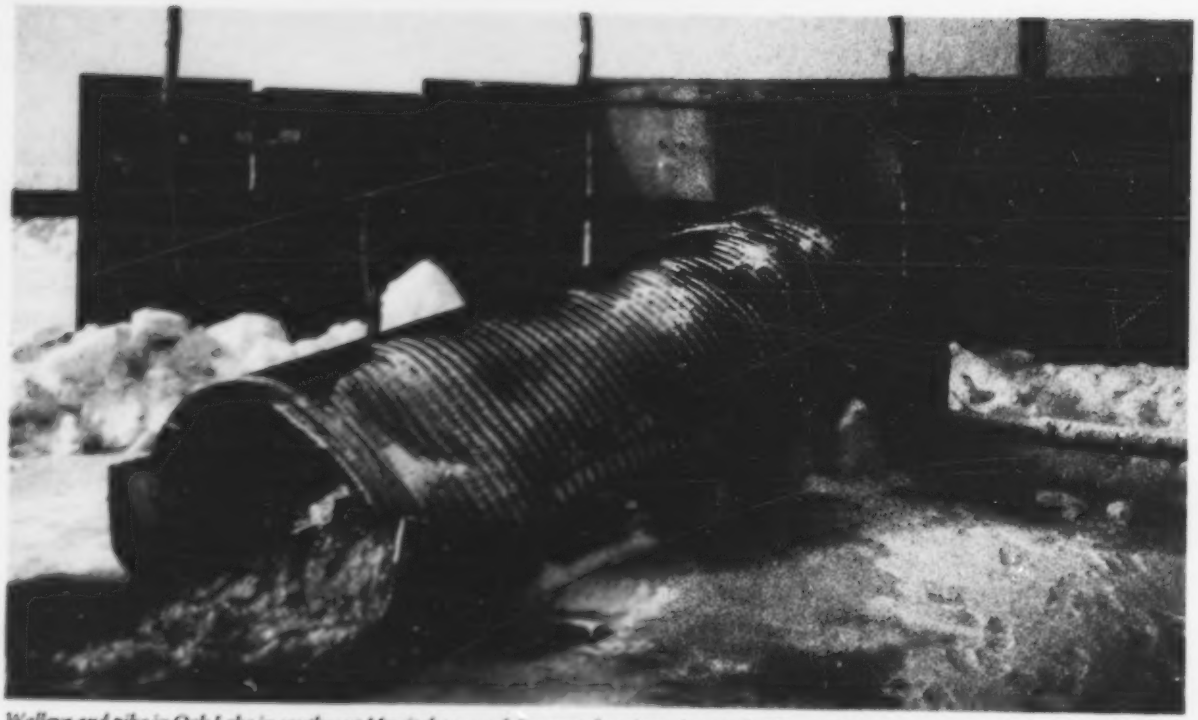
The Fisheries Branch has developed *A Strategy For Managing Manitoba's Fish Habitat* covering the protection, rehabilitation, and enhancement of fish resources.

Nutrient Overloading

Nutrient overloading is another factor in the decline of fish. Animal waste from livestock operations, domestic sewage, and agricultural chemicals carried into lakes and streams can overload the water with nutrients, promoting the growth of algae and other water plants that, on decaying, use up valuable supplies of oxygen in the water, killing the fish.

Siltation caused by cattle grazing along river banks can destroy water quality and fish habitat. Restoration includes construction of fences to keep livestock away from erodible streambanks except at selected watering points.





Walleye and pike in Oak Lake in southwest Manitoba were dying over the winter from lack of oxygen because of low lake levels. Fisheries staff, with help from the Oak Lake Advisory Committee, installed pumps and a series of baffles that aerate water to restore oxygen levels and keep sport fish populations alive through the winter.

Oxygen Depletion

Oxygen depletion means there is not enough oxygen in the water to keep fish alive. It is a major problem in Rock, Pelican, and Swan lakes in southwest Manitoba. These and other lakes in the Grassland Region are prone to oxygen depletion because they are shallow, naturally rich in nutrients, and often loaded with chemical fertilizers, sewage, runoff from feedlots, and other nutrients that boost plant growth. When the plants start to decay in the fall, they use up most of the oxygen in the water. The fish usually die in midwinter when the oxygen is completely exhausted and cannot be replenished from the atmosphere because of ice cover.

Oxygen depletion can also be caused by spills of human and animal sewage and other polluting materials that take up oxygen in the water when they decay.

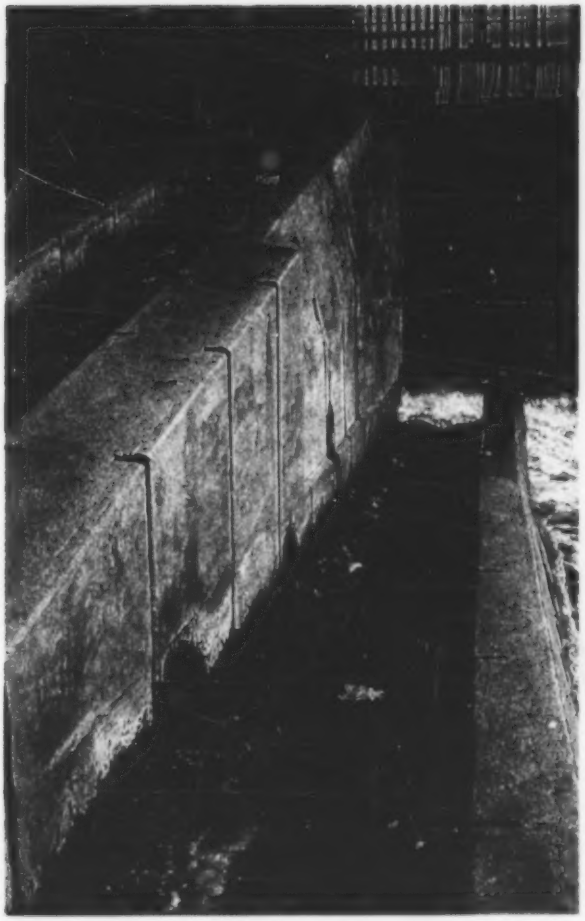
One way to keep oxygen levels up is to install an aerator – a compressor that forces air into a length of perforated tubing on the bottom of the lake. As the bubbles rise from the diffuser, some of the oxygen they carry dissolves in the water. The bubbles also set up currents that keep ice from forming over part of the lake. The area that remains open serves as a window for air to enter the water, raising oxygen levels. These systems have been installed in some lakes and reservoirs, mostly in southwestern Manitoba, to reduce fish kills during winter.

Water level control structures can also prevent winterkill from oxygen depletion. The structures raise water levels, allowing an increase in the amount of oxygen present. Even another half metre of water spread over the area of a pond or lake can be enough to prevent oxygen depletion. Higher water levels also dilute plant nutrients, reducing plant growth and the amount of vegetation that decays later on.

Faulty Stream Crossings

Poorly constructed stream crossings cause erosion and sedimentation, block the passage of fish, flood areas upstream, and leave streambeds dry downstream. Along the access road to the lower Nelson River hydroelectric generating station, erosion at stream crossings destroyed several kilometres of important brook trout habitat. In the summer of 1989, incorrectly installed culverts killed white suckers on Hayward Creek near Snow Lake. The culverts had been installed so high that they backed up the water, reducing flows downstream to a trickle and preventing the fish from swimming upstream. Below the culverts, water temperatures rose, killing the fish trapped there. The culverts were replaced to alleviate further problems.

Stock-watering dams and stream crossings can be modified to allow the passage of fish. The Fisheries Branch has prepared *Recommended Fish Protection Procedures for Stream Crossings in Manitoba* to help engineers and developers design new stream crossings or modify old ones to limit damage to fish and fish habitat.



Fishway on the Red River at Lockport

Hydroelectric Development

Hydroelectric development converts river habitat to reservoir habitat, causing fish species to change, from those that prefer rivers to those that prefer calm water. On the Churchill and lower Nelson rivers, it will likely cause such a shift, toward pike and other sport species that prefer still water.

Dams and control structures also interfere with fish migration and spawning runs, as happened to brook trout following hydroelectric development on the Nelson River. Populations elsewhere in the Northern Transition/Tundra Region appear immune to such stresses. Reservoirs along the Nelson may support remnant sturgeon populations that could even become self-sustaining.

Fishways or fish ladders are structures that allow fish to swim around dams and other barriers. They use baffles that slow flows and form compartments where fish can rest. But they work only for certain species. Whitefish, a medium-size fish, has been known to use ladders. Lake sturgeon, a large fish, and minnows, have difficulty. A fishway has been installed on the Fairford River mainly for walleye, and an old one on the Red River has been put back into operation for sauger, goldeye, walleye, and catfish.

Federal and provincial agencies monitor fish to spot pollution problems with hydroelectric developments. Special studies assess fish stocks and identify measures to prevent, mitigate, or rehabilitate environmental and biological impacts. Brook trout and sturgeon are monitored in the Nelson.

Introduced Species

Diversions, such as the Garrison, can introduce new species that make life difficult for resident populations by competing for food and habitat, killing resident fish, introducing diseases or parasites, and even changing the environment, as in the case of carp that stir up sediments with their "rooting" behaviour.

Exotic fish likely to enter Manitoba soon and threaten our fish include grass carp and zander, a large fish resembling walleye that is native to Europe. Zander were recently introduced in North Dakota and grass carp in Alberta. Experts warn that it is only a matter of time before zebra mussels, a major threat to our fisheries, reach our waters from the Great Lakes.

In 1990, three rainbow smelts were caught in Lake Winnipeg. Large populations could threaten walleye and whitefish. The smelts probably entered Manitoba from Red Lake, Ontario, along the Winnipeg River.

Acid Rain

Most of our lakes have a buffering capacity that keeps them from turning acidic. The buffering capacity derives from large amounts of limestone and calcareous clays and tills that underlie a good portion of Manitoba. Some lakes along the east side of Lake Winnipeg, in the Canadian Shield, are susceptible to acidification because they are on bedrock and soils that do not contain calcium carbonate.

Sulphur emissions are a major factor in the production of acid rain. The province is committed to reducing sulphur emissions within Manitoba and has people working on national programs to reduce sulphur emissions across Canada (*see* **Air**).

Pollution

Pollution from acid mine drainage or heavy metals is not only toxic to fish but also harmful to the people and animals that eat them. Heavy metals are discharged from mines and smelters or released from flooded soils (*see* **Mining**).

Mercury contamination is of primary concern in Manitoba because it has affected the livelihood of northern people. Fish they could once sell commercially became unsafe. The amount of mercury in fish increases with the area of land flooded. Mercury contamination may persist for several decades before levels drop.

When the level of Southern Indian Lake was raised 9 metres and three-quarters of the flow of the Churchill was diverted into the Nelson, extensive areas were flooded, releasing mercury from the soil and causing unacceptable concentrations of mercury in fish found in lakes along the diversion route.

Wood and wire fence to prevent fish kills in Cooks Creek. The fence keeps fish from migrating into the warm waters released by Manitoba Hydro's thermal generating station at Selkirk. If the fish become acclimatized to the warmer water from the station, they can die when the station stops operating and the water cools quickly.

Mercury concentrations in walleye rose from about 0.2 to 0.8 parts per million.

Mercury levels in whitefish have since declined to concentrations at or close to those found in fish before the diversion was built, but levels in pike and walleye have remained high. Within each species, older and usually larger fish have higher mercury concentrations than younger, smaller fish.

Discharges from sewage lagoons into water bodies have been known to kill fish. Un-ionized ammonia in the effluent interferes with oxygen transport across gills. Instances have occurred on the Whitemouth and Whitemud rivers and on a Lake Winnipeg marsh, with charges being laid against the people involved.

Chemicals enter aquatic environments primarily from farming operations, although they may also originate as effluents from manufacturing and industrial plants. Many of the fertilizers, pesticides, and insecticides used on farms or in forests harm fish or the food that fish eat. Chemicals reach aquatic environment in rain and snow, surface runoff, contaminated groundwater, or deliberate applications for pest control. Effects range from changes of colour and alteration of behaviour to damage of reproductive organs and reduction in offspring survival. Feeding larvae and juveniles are the most vulnerable; eggs and larvae with yolk sacs, least. Herbicides are less toxic than fertilizers and pesticides. They often affect fish indirectly, by destroying vegetation, a process that uses up precious supplies of oxygen, suffocating fish.

Manitoba Natural Resources, Environment, and Health distribute guidelines on public consumption of mercury-contaminated fish. Marketing restrictions are imposed on fish caught in lakes with high mercury levels. Regulations on pollution are defined in the federal Fisheries Act. All pesticides must be registered and applicators must observe restrictions specified in pesticide use permits which are granted by Manitoba Environment. Manufacturers supply recommendations for the use of their chemicals.

Over-Fishing

Over-exploitation of fish populations refers not only to the removal of too many fish but also to the increased traffic that disturbs spawning grounds and accelerates eutrophication (*see* **Water**). Some fish fare better than others. Walleye recover quickly because they mature at 4 to 6 years and are prolific. Lake sturgeon are extremely vulnerable to exploitation because they take 15 to 25 years to reach maturity.

To stock Lake Winnipegosis, walleye fingerlings are raised in natural bays that are screened off with culverts and gates to keep out coarse fish. Another technique to protect walleye fingerlings is to release them in the fall when they are big enough to cope with predators.

Dealing With Over-Fishing

Measures that deal with over-fishing focus mainly on reducing commercial fishing quotas and angler creel limits. Here are several examples.

Putting the "Winnipeg" back in Winnipeg Goldeye

An important local industry on Lake Winnipeg in the 1920s, the goldeye fishery declined and was finally wiped out during the 1930s under pressure from tremendous demand, top prices, and more efficient fishing equipment. Until recently, much of the famed smoked "Winnipeg goldeye" had to be imported from lakes and rivers in Alberta, Saskatchewan, Ontario, and North Dakota. Today, through harvest management, populations have recovered and the goldeye smoked and sold in Manitoba comes from Lake Winnipegosis and other Manitoba lakes.

Restoring Lac du Bonnet

Over-fishing of Lac du Bonnet in the 1970s and early 80s eventually led to the collapse of a popular sport fishery that had supported related industries, including lodges. Anyone could fish there, including anglers from more than 2,000 cottages around the lake and from nearby Winnipeg, and the lake was the setting for catch and release fishing derbies.

In 1987, the Fisheries Branch took the first of several steps to rehabilitate the fishery. In several spawning areas of the lake, it delayed opening of the angling season to ensure adult walleye were not harvested before spawning. It set a minimum size on walleye to protect stocks of young fish which would become the future spawning base of the population. In cooperation with cottage associations, game and fish associations, and schools, it started projects to enhance stream and reef habitat for walleye spawning, and stocked the lake with 7 million walleye fry between 1987 and 1989.

The effort has paid off. Adult walleye are known to have used Coca Cola Falls and other improved spawning areas. Large numbers of walleye under the minimum size limit are frequently caught and released. The next few years are expected to see numbers of adults up, with plenty of good spawning habitat for them. The Fisheries Branch is now thinking of changing the regulations to maintain walleye once the lake is back to normal.

Fishermen Agree to 3-Year Closure of Winnipegosis

The open-water commercial fishery on Lake Winnipegosis was closed in 1986 because of continued overharvesting that had brought about biological and economic declines in the fishery, and in particular, a drastic reduction in walleye stocks. It was reopened in 1989 after a 3-year closure agreed to jointly by commercial fishermen and the province. When the fishery reopened, the province bought licences from 18 commercial fishermen to ease pressure on the lake, improve walleye stocks, and give the remaining 29 commercial fishermen better returns.

The 1989 season proved disappointing, with only 94,000 kilograms of walleye harvested, compared to 338,000 kilograms in 1982, one of the better years. The low catch was not surprising however, since the first significant spawning during the closure had only taken place in the spring of 1987. The results of this spawning are not expected to contribute significantly to the commercial harvest until 1991.

Waterhen Residents Chip in to Stock Local Lake

Chitek Lake in the Interlake is the setting for a new commercial fishery developed by annually stocking the lake with walleye. During the 1989/90 winter season, local fishermen harvested 72,447 kilograms of walleye, generating nearly $195,000 for the economy of nearby Waterhen. Before the lake was stocked, it produced only 14,000 kilograms. Commercial fishermen from Waterhen help cover the cost of stocking Chitek and other lakes in the area.

Protecting the Resource

Measures to encourage conservation, improve your chances of catching a trophy fish, and protect our commercial fisheries range from stocking to derby permits. But as the sale of conservation licences shows, the future of fishing is not in the hands of the Fisheries Branch alone.

Setting Limits on Fishing

"Harvest potential" refers to the number of fish that can be taken from a lake or region without reducing fish productivity or depleting stocks. In Manitoba, harvest potential is calculated from catch statistics and data on the number, size, depth, and chemistry of our lakes and rivers. Walleye, whitefish, and other prime fish species are managed by catch limits or quotas. The harvest potential for these types of fish is about 20 million kilograms. The harvest potential for less valuable or coarse fish species has been set at 16 million kilograms.

Amounts of fish actually harvested differ from the harvest potential depending on fish habitat and biology, fish prices, operating costs, market demands, social pressures, and numbers of fishermen. The actual harvest can exceed the harvest potential when costs are down and demand and prices are up.

Stocking

Since 1984, the Fisheries Branch has stocked lakes and rivers with more than 415 million fish, mainly walleye fry, to help commercial fisheries. The Branch also stocks sport fishing waters with walleye or trout.

Stocking programs are designed to:

- establish desirable species where there were none before
- maintain fish numbers where natural reproduction cannot
- supplement declining or over-harvested populations so that they can recover
- diversify fishing opportunities in areas where demand exceeds supply.

Conservation Licences and Derby Permits

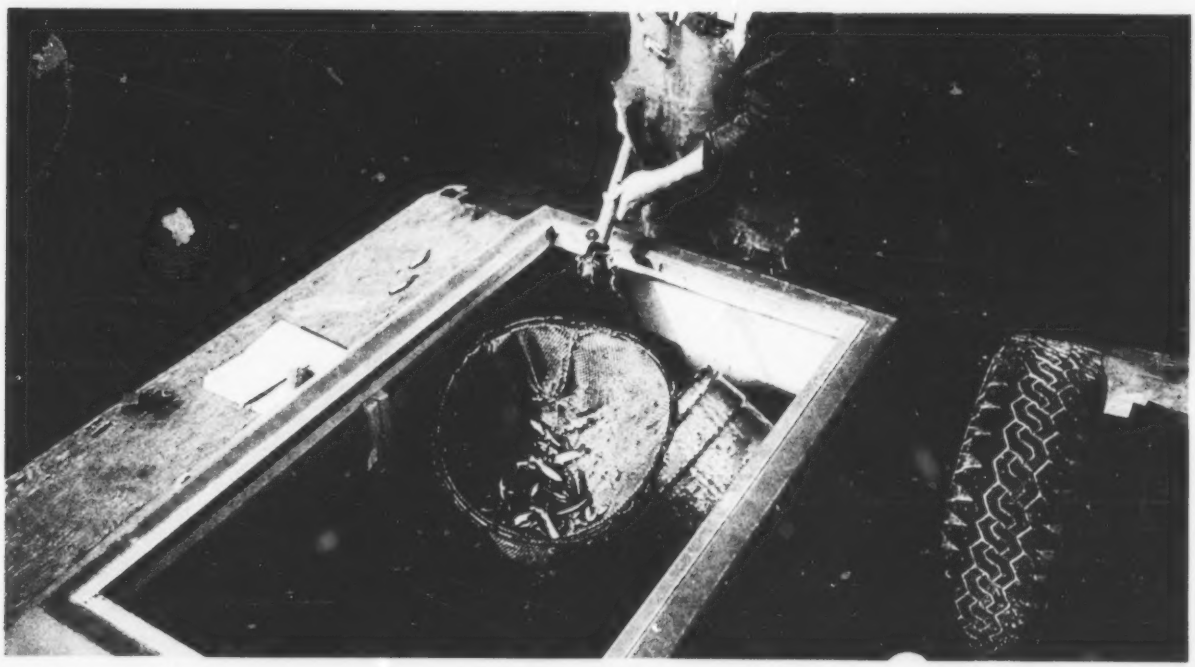
Conservation licences carry reduced creel limits for highly valued species such as walleye, sauger, northern pike, lake trout, smallmouth bass, and channel catfish. They cost half as much as regular season licences. Since conservation licences were adopted for nonresident and resident anglers, 45% of each group has bought them.

Fishing derbies with more than 25 registered entrants must operate under special, no-cost permits. Participants must hold fishing licences. All trout, walleye, smallmouth bass, and catfish must be released during derbies.

Catch/Release Angling

Anglers are releasing more and more of the fish they catch. In 1980, sport fishermen released 48% of the fish they caught. By 1985, the figure had risen to 55%. Fishermen appreciate the value of conserving our fish resources and have taken a greater interest in the recreational aspects of fishing.

Manitoba's provincial hatcheries raise thousands of young fish every year to be used in stocking programs. Species most commonly reared are trout and walleye.



Cooperative Management

Fish Futures

The 1990 Sport Fishing Guide was published by Fish Futures Inc. with Manitoba Natural Resources. The project cut production costs for the Fisheries Branch and raised funds for Fish Futures, a non-profit organization dedicated to public education and the preservation and enhancement of fisheries.

The 1990 Guide featured a fish identification chart, expanded classified advertising, and authorized repair depot listings. All profits from its publication will go toward enhancing our freshwater fisheries.

Fish Futures has also studied movements and concentrations of catfish and walleye populations in the Red River, offered public education programs at Lake of the Prairies, and helped fund a walleye spawn-taking project at Ebb and Flow Lake.

User Management

The Fisheries Branch invites anglers to lend a hand in the management of our sport fisheries. Local users have suggested innovative sport fishing regulations to go in fisheries management plans tailored to a specific lake. Public meetings are often held to encourage feedback from people who want to help enhance sport fishing in their area. In 1990, lodge operators, local game and fish associations, municipal and town councils, cottage owners, and seasonal campers were invited to attend public meetings on the future of the Lac du Bonnet sport fishery. On a broader scale, meetings were held with cottage owners, outfitters, lodge owners, and other interest groups in Whiteshell Provincial Park towards development of a fisheries management strategy for the entire park.

Private organizations and groups interested in sport fishing worked with the Fisheries Branch in 1989 to 1990 to cooperatively manage regional fishery resources. Groups included Swan Valley Sport Fishing Enhancement Inc., Intermountain Sport Fishing Enhancement, Fish Futures Inc., Greenstone Development Corporation, Concerned Anglers of Manitoba, Manitoba Wildlife Federation and associated clubs, Rocky Lake Advisory Committee, Clearwater Lake Advisory Committee, Kississing Lake Advisory Committee, Dauphin Lake Advisory Board, and the Manitoba Lodge Owners Association.

Swan Valley Sport Fishing Enhancement Inc., Intermountain Sport Fishing Enhancement, and Fish Futures Inc. hold annual fund raising banquets to raise money for habitat improvement projects, fish stocking, kids' seminars, angler surveys, and fisheries research and management programs.

Quota Entitlement

Commercial fisheries in Manitoba are struggling for economic viability. But economic, biological, and market constraints being what they are, hiking lake quotas and offering subsidies to fishermen are not solutions. Instead, the Fisheries Branch works with the Lake Winnipeg Commercial Fishermen in setting up a quota system that maintains the overall lake quota while allowing flexibility in the distribution of individual quotas among fishermen.

A quota entitlement system works by dividing the lake quota (total weight of fish that can be harvested from the lake, say 200,000 kilograms) into a number of quota entitlements. Quota entitlements represent a fixed portion of the lake quota, and are not necessarily equal. One quota entitlement may be for 2,000 kilograms while another is for 4,000 kilograms. Fishermen may own several quota entitlements, and may transfer them for a mutually agreed upon price. The value of a fisherman's quota entitlement varies according to such factors as the price of fish and whether equipment is included. Restrictions include a maximum number of quota entitlements for any one fisherman, requirements of residence, and experience for eligibility.

The quota entitlement system on Lake Winnipeg, introduced in 1985, has led to fewer fishermen and higher average quotas for those left. Fishermen transfer their quota entitlements to increase their incomes, while the Fisheries Branch maintains the overall lake quota to prevent overharvest.

Go Barbless

Manitoba decided to go barbless throughout the province in 1990 as part of the trend to release more fish. Releasing a fish back to the water may be difficult for some people, but if future generations are to enjoy fishing, we need to look after our fish population now. Using barbless hooks makes it easier for anglers to release what they catch. It also means the fish are handled less, increasing their chances of survival.

Public Information and Education

Staff at the Fisheries Branch give public seminars and publish reports on fishery programs and a range of issues, including stocking, regulations, derbies, fish populations, and fish habitat.

Acts and Regulations

Manitoba's Fisheries Act controls and regulates the marketing of fish in Manitoba, defines the duties and powers of inspectors, and covers regulations for the inspection of fish, freshwater marketing, and fishermen's loans.

The federal Fisheries Act defines the roles of fishery officers and guardians, and covers leases and licences, offences and punishments, and regulations on building fishways, protecting fish habitat, and preventing pollution. Under this act, Manitoba Fishery Regulations apply to the management and control of fish that are found in or taken from any waters of Manitoba except waters in a national park or subject to a fish farming licence. Items defined include close times, fishing quotas, licences, possession and transportation of fish, sport and commercial fishing, and ticketing.

The Manitoba Environment Act protects fish habitat by ensuring that new developments meet requirements established in the environmental review process.

The *Manitoba Fisheries Strategy* centres on issues and opportunities that affect management of the resource, its use, and the long-term benefits to society. It also deals with the maintenance of healthy aquatic ecosystems and the continuing productivity of fish resources in order to support viable fisheries.

A Management Strategy for Manitoba's Commercial Fishery is designed to ensure a consistent and coordinated approach to commercial fisheries management. It also offers guidance in management activities, assists in decision-making, and guides the development of lake or fishery specific management plans.

A Strategy for the Management of Manitoba's Fish Habitat explains fish habitat issues and concerns and identifies goals for ensuring that fish habitat is conserved wherever possible. It stresses mitigation, rehabilitation, and enhancement to minimize unavoidable losses.

A Strategy for Stocking Fish in Manitoba pinpoints locations where stocking can be used as an effective fisheries management tool. It offers guidance in proposing, evaluating, and implementing specific stocking projects, and in allocating limited supplies of hatchery-raised fish. It also covers introductions, maintenance stocking, supplemental stocking, and spawn-taking and rearing practices.

Trends

Fish management ——— **Better**

Private sport fishing organizations help the Fisheries Branch develop strategies, regulations, and acts to better manage fish and their habitat.

Fish habitat ——— **Better**

A number of measures are under way to improve fish habitat damaged by siltation, eutrophication, stream channelization, and changing land use. Measures range from improving fish habitat though the use of aeration systems, flushing sediment from spawning sites, and controlling water levels to incorporating habitat protection and development measures into resource and land use plans and developing a strategy for managing fish habitat for Manitoba.

Influx of non-native species ——— **Worse**

Zander, grass carp, and zebra mussels are likely to enter Manitoba waters soon, posing problems for native species. Preventive measures include water control structures that help block unwanted species, but public awareness is often the key.

Harvest control ——— **Better**

Licence buy-back programs, conservation licences, derby permits, quota entitlements, and catch/release programs are on the increase, encouraging resource conservation and improving the quality of fishing.

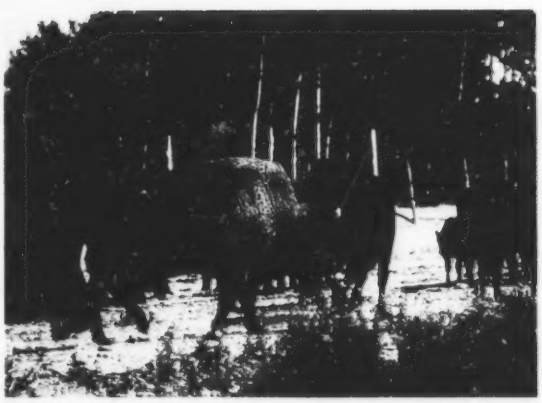
Public participation ——— **Better**

User groups and others are taking advantage of public consultation programs to lend a hand in managing the fishery resources in their areas.

SPECIAL SPECIES

Special species are plants, animals, or fish that are rare, threatened, endangered, extirpated, or extinct. They form a small but important part of Manitoba's flora and fauna.

This section presents an overview of Manitoba's special species since they provide an indication of the environmental health of the province. Generally speaking, the longer the list of rare, threatened, endangered, extirpated, or extinct species, the worse off the state of the environment. (Insects, shellfish, and other invertebrates have been excluded because of an overall lack of information on their status.)



Intentional introduction. Wood bison, the largest land mammal in North America, once roamed the forests of northwestern Canada. In February 1984, 30 wood bison were imported to the Waterhen area. The herd flourished, but when the animals were released from the enclosure, they wandered into the agricultural region and had to be rounded up. The project involved several agencies working in cooperation with the Saulteaux of the Waterhen Band.

Accidental introduction. Ranges of plants, animals, and fish can be expanded through accidental or intentional introduction of a species to a new area. The hackberry, a tree native to much of the United States and Mexico, is thought to have been introduced to Manitoba as a seed carried by a migratory bird. The hackberry tree now grows on the beach ridge at Delta and a few other well-drained areas near the south end of Lake Manitoba.

Special Species Lists - Preliminary

The following lists of special species are preliminary and subject to revision by the Endangered Species Advisory Committee, a group appointed by Lieutenant Governor under the authority of The Endangered Species Act. See **Manitoba Plants and Animals** for scientific names.

Rare Flora and Fauna of Manitoba – 51

A species is considered rare or of special concern when it has a restricted range, occurs sparsely over a wider area, or is declining in numbers. Peripheral species are rare only because they have reached the limit of their range in Manitoba.

Plants

bloodrot
Dutchman's breeches
eveningstar
fragrant white water-lily
grass pink orchid
great plains ladies'-tresses
hackberry
Jack-in-the-pulpit
liverleaf
low milk-vetch
pincushion cactus
prairie white fringed orchid
rose pogonia
small purple fringed orchid
western silver-leaf aster
western spiderwort

Birds

American white pelican
bald eagle
black tern
Caspian tern
golden eagle
great gray owl
least bittern
osprey
prairie falcon
red-necked grebe
Ross' gull
western grebe

Mammals

badger
bobcat
cougar
fox squirrel
mule deer
plains pocket gopher
wolverine
wood bison

Amphibians

great plains toad
green frog
mink frog
plains spadefoot toad

Fish

banded killifish
bigmouth buffalo
blackchin shiner
bluntnose minnow
four-horned sculpin
golden redhorse
hornyhead chub
lake sturgeon
northern brook lamprey
shortjaw cisco
weed shiner

Threatened Species of Manitoba – 6

A threatened species is one that is likely to become endangered within the foreseeable future over all or most of its range if factors affecting its vulnerability are not reversed.

Birds

Baird's sparrow
ferruginous hawk
loggerhead shrike

Mammals

long-tailed weasel

Reptiles

northern prairie skink
plains hognose snake

Endangered Species of Manitoba – 5

A species is endangered when its existence is threatened with immediate extirpation or extinction throughout all or a major portion of its range. A species is extinct when it no longer exists anywhere in the world. The passenger pigeon is a well-known example.

Plants

small white lady's-slipper

Birds

burrowing owl
Eskimo curlew
peregrine falcon
piping plover

Extirpated Species of Manitoba – 10

"Extirpated" refers to those species that survive elsewhere but no longer exist in the wild in Manitoba.

Birds

greater prairie-chicken
long-billed curlew
trumpeter swan
whooping crane

Mammals

gray wolf (plains race)
grizzly (plains race)
muskox
plains bison
pronghorn
swift fox

Source: Manitoba Natural Resources

Young burrowing owls

Spotlight on Special Species

Ferruginous Hawk

The ferruginous hawk is the largest of the broad-winged hawks. Known to nest in southwestern parts of the province, this hawk prefers open, arid habitat with limited tree growth and cultivation. It needs large areas of grassland to survive.

The decline in numbers stems from the cumulative effects of pesticide poisoning in the food chain, loss of grassland habitat to agriculture and to the invasion of trees when prairie fires are curtailed, and an intolerance to human activity near nesting sites. Indiscriminate shooting, reduction in prey species, and lack of suitable nesting sites have also been implicated.

In 1987, volunteers built 64 artificial nest structures for installation by Natural Resources staff. Volunteer birdwatchers and provincial biologists continue to monitor the population with financial assistance from World Wildlife Fund Canada.

Northern Prairie Skink

The northern prairie skink is Manitoba's only lizard. When seized by a predator, the animal's tail breaks free and flips about for a few minutes. The tail grows back again, but shorter each time!

Skinks, never very common in Manitoba, inhabit open sandhill country in the southwest. Habitat alterations are threatening numbers.

Burrowing Owl

The burrowing owl occupies desert and open grasslands, feeding mainly on grasshoppers and small rodents. Unique among owls, it nests on the ground in abandoned burrows of badgers and ground squirrels. It is now restricted to the extreme southwest corner of the province.

In Manitoba, the known number of nesting pairs dropped from 110 in 1978 to 76 in 1982, to 28 in 1988, and to 19 in 1990. The main cause is secondary poisoning by insecticides used to control grasshoppers. Loss of pastureland and suitable nesting burrows, owl-vehicle collisions, careless shooting, and predation are contributing factors.

Trumpeter Swan

Trumpeter swans once nested at Norway House and Shoal Lake in Manitoba. They are the largest species of North American waterfowl.

By the turn of the century, overhunting had brought the swan to the verge of extinction. In 1933, there were only 66 swans but with the establishment of refuges, captive-breeding programs, and winter feeding programs, the swans have made a remarkable comeback. Between 11,000 to 13,000 trumpeter swans breed in several provinces and states today. The first facility to breed the trumpeter swan in captivity was the Delta Waterfowl and Wetlands Research Station at Delta, Manitoba. Since 1957, the "Delta" has made captive-reared birds available to interested agencies.

Small White Lady's-Slipper

The small white lady's-slipper usually grows in ungrazed, open, and semi-open pastures and meadows in southcentral or southwestern Manitoba. Remnant colonies can still be found in the Brandon and Lake Francis areas. Numbers have declined drastically over the past 50 years because of habitat loss to farming. Lady's-slippers take from 9 to 15 years to develop from seed to blooming plant.

Pronghorn

Pronghorn antelope once roamed the Souris Plains and Brandon Hills areas of Manitoba. Their range extended as far east as the Red River, but excessive hunting and the encroachment of civilization, in particular, fences, wiped out the population. The last known pronghorn in Manitoba was shot at Whitewater Lake in 1881.

Today, the occasional animal wanders into Manitoba from North Dakota and Saskatchewan. Hunting of pronghorns is not permitted in Manitoba.

Passenger Pigeon

The passenger pigeon was the world's most abundant land bird. Flocks of hundreds of millions would obscure the sky over the hardwood forests of eastern North America. Its breeding range extended as far west as eastern Saskatchewan.

Pigeon Bluff, Manitoba, was named after the hordes of pigeons that once lived there.

The combined effect of market hunting and habitat destruction resulted in a drastic decline in the population from 1850 to 1870. Unable to recover, the passenger pigeon became extinct in 1914.

Threats to Special Species

Loss of habitat, chemical poisoning, human disturbances, over-exploitation, and a combination of these factors can threaten the survival of special species.

Special plant species are very susceptible to the effects of environmental change brought about by land clearing, wetland drainage, overgrazing, industrial and agricultural pollution, hydroelectric projects, and recreational overuse. For example, the Grassland Region has suffered losses of valuable habitat through fire control, tillage, drainage, grazing, pasture improvement, and the spread of weeds. Loss of habitat to agricultural activities has restricted the small white lady's-slipper to marshy grasslands around Brandon and Lake Francis.

Green frogs, mink frogs, and other species occurring at the limit of their range are controlled primarily by climatic conditions or habitat preferences. Bobcat numbers are kept low because of deep snow and lack of cover in which to hide. Grass pink orchids, found in sphagnum bogs, are threatened by the clear-cutting of forests.

Sturgeon populations in the province have been depleted by overfishing and the construction of dams. A preference for very deep water limits numbers of shortjaw cisco and four-horned sculpin.

In southern Manitoba, habitat destruction by clearing, draining, and cultivating, urban sprawl, and the construction of highways is the primary cause of declining populations of prairie long-tailed weasel, badger, mule deer, Baird's sparrow, black tern, and burrowing owl.

Northern prairie skink and plains hognose snake populations are threatened by habitat altered through invasion of leafy spurge or aspen parkland and an accumulation of excessive leaf litter. Loss of habitat in their ranges is also important for great gray owl, bald eagle, osprey, red-necked grebe, and least bittern.

Pesticides to control insects, weeds, rodents, and other pests have also reduced populations. DDT and other organochlorine compounds in the 1950s caused the decline of the peregrine falcon, prairie falcon, and bald eagle. Pesticides accumulated in their bodies, resulting in thin-shelled eggs, nest abandonment, and death. The use of pesticides to control grasshoppers is thought to be linked to a decline in the number of burrowing owls. The cumulative effects of pesticide poisoning in the food chain may be one reason for fewer ferruginous hawks, loggerhead shrikes, western grebes, red-necked grebes, ospreys, least bitterns, and black terns. Loss of prey through pesticide control creates problems for badgers.

Human disturbances, particularly at nesting time, are a major threat to Caspian terns, western grebes, bald eagles, piping plovers, and American white pelicans. Recreationists who destroy nests and nesting sites on beaches have reduced the reproductive success of piping plovers.

Disturbance of nesting sites led to the decline of American white pelicans in the 1960s and 1970s and their listing by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1978 as threatened. Through protection, research, and education programs, their numbers have been restored and they have been removed from the COSEWIC threatened list.

Illegal shooting has affected the bald eagle, golden eagle, and osprey. Hunting pressure, competition from white-tailed deer, and brain worm contributed to the decline of mule deer in Manitoba.

Small white lady's-slipper

Preserving Our Special Species

The province's special plants, animals, and fish are at risk primarily because of human activities. Unless efforts are made to alleviate the situation, some species may face extinction.

The Endangered Species Act is the only legislation that deals specifically with the preservation of endangered species in Manitoba (*see* **Wildlife**). Other legislation has, however, proven useful in protecting plants, animals, fish, and their habitats.

The Wildlife Act offers some protection by preserving habitats. Rare species are also guarded through the establishment of ecological reserves under The Ecological Reserves Act. Regulations under The Forest Act and The Provincial Park Lands Act prohibit the removal or destruction of any flora or fauna within provincial forests and parks without the permission of the Minister. The National Parks Act strictly controls and in most cases prohibits resource exploitation, and areas in national parks are often zoned to restrict human impact. Another form of protection is the restricted access imposed on lands under the jurisdiction of the Department of National Defence (Camp Shilo Military Reserve - Carberry Sand Hills).

Conservation and Management Programs

Rare and endangered species management in Manitoba consists of releasing captive-reared young, transplanting young or family groups, building and protecting nest sites, and monitoring populations.

The peregrine falcon release project is part of a nationwide effort to try to bring back this species. The birds are obtained from the Canadian Wildlife Service in Wainwright, Alberta. Fed indirectly to maintain their wildness, the falcons are released from pens on the top of high buildings when they are able to fly. They keep returning for food until they can hunt for themselves. As of August 1990, 49 peregrine falcons had been released in Manitoba.

Manitoba's Burrowing Owl Restoration Program, which began in 1982, includes annual surveys of active nesting sites, installation of artificial burrows, and the reintroduction of owls from Saskatchewan to bolster provincial populations. Landowners in the grassland area have cooperated by protecting nest sites, leasing critical breeding grounds, and taking steps to reduce or eliminate pesticides potentially harmful to this species.

Ferruginous hawks, loggerhead shrikes, and Baird's sparrows, of the grassland area in the southwestern corner of the province, are the subject of studies along with the burrowing owl. Plans include setting aside tracts of native grasslands and related habitats to benefit several of these and other species.

A prime great gray owl breeding ground in the mixedwood forest area in the southeast corner of the province has been designated as a voluntarily protected ecologically significant area (*see* **Special Areas**).

Akudlik Marsh near Churchill, the only known nesting area in North America for Ross' gull, has been set aside for the gulls' protection. The Walter Cook Special Conservation Area near Grand Rapids protects the largest breeding and staging area for piping plovers, Manitoba's only indigenous species that is endangered.

The numbers and distribution of polar bears are routinely monitored in northern Manitoba, and the Polar Bear Control Program out of Churchill seeks to prevent confrontations between people and bears. Wood bison are being raised by the Saulteaux at Waterhen for release into the wild. The Pen Island caribou herd is under co-management with Natives from Manitoba and Ontario and representatives from Manitoba Natural Resources and Ontario Ministry of Natural Resources.

In 1989, a pair of peregrine falcons raised a brood of four chicks on the roof of the Delta Winnipeg Hotel – the first confirmed nesting of peregrine falcons in Manitoba in recent years. In 1990, the same pair returned to their "penthouse suite" and raised two more young. The success of the program has prompted plans for similar releases at the University of Manitoba and McKenzie Seeds in Brandon.

Gray'l, a 7-year-old great gray owl raised in captivity, is the focus of research, education, and fund-raising. A regular visitor to schools, Gray'l has been touched by about 5,000 Manitoba school children.

Volunteer Programs

Landowners, with such organizations as the Manitoba Naturalists Society, World Wildlife Fund Canada, Wildlife Habitat Canada or under the province's Ecologically Significant Areas Program, have set aside parcels of land for the protection of the small white lady's-slipper and other endangered species.

Many volunteers work on the endangered species programs.

Education Programs

Because piping plover breeding sites on public beaches are in jeopardy from human disturbance, conservation efforts for this species involve local groups and educational efforts at the community level.

In the summer of 1984, a half-starved great gray owl chick, just 3 weeks old, was taken from a nest in southeastern Manitoba under provincial permit and raised in captivity. Imprinted on humans, this tame, tolerant bird is used by Manitoba Natural Resources for research, education, and fund-raising.

Now 7 years old, "Gray'l" (short for gray owl), as this female is known, has appeared in public on many occasions. Thousands of people have seen her on local and national television, and many have enjoyed watching her during public presentations.

Trends

Habitat ——— **Worse**
Loss of habitat is a major concern for special species, in particular plant species which can not move away from environmental stresses.

Number of burrowing owls ——— **Worse**
Known numbers of nesting pairs dropped to an all time low of 19 in 1990, mainly because of secondary poisoning by insecticides, habitat loss, and careless shooting.

Environmental awareness ——— **Better**
People are more aware of the fragility of certain species and are cooperating in controlling activities near breeding and nesting sites.

Conservation and habitat management programs —— **Better**
Rare and endangered species are managed through programs ranging from releasing captive-reared young and transplanting young or family groups, to building and protecting nesting sites and monitoring populations. The success of the peregrine falcon release project has prompted plans for similar releases at other locations in Manitoba.

Volunteer efforts ——— **Better**
Most of the endangered species programs are assisted by volunteers who take an active interest in preserving species at risk.

SPECIAL AREAS

Special areas are designated by legislation to protect and preserve the province's unique physical, cultural, and natural features. Parks, heritage resources, ecologically significant areas, and heritage rivers make up this category. Some special areas are administered by the federal government, others by provincial or municipal governments.

Special areas share a common goal: to conserve delicate ecosystems, representative samples of flora and fauna, and significant aspects of Manitoba's heritage. The social, psychological, educational, and economic benefits they provide are important to the enrichment and fulfilment of our lives and the lives of future generations. Manitoba was the first province in Canada to endorse the Endangered Spaces Program put forward by the United Nations and the World Wildlife Fund Canada. Manitoba is prepared to make a significant contribution towards the program's requirement to protect 12% of Canada's natural regions from logging, mining, hydro development, and any other activities which would significantly disturb habitat. Our contribution will be about 12% of our land base. The province has agreed to establish a network of protected areas with the goal of ensuring that a portion of each of our natural regions is protected by the year 2000. This protection will not prevent or interfere with local resource uses, such as berry picking, horseback riding, hunting, fishing, and gathering of firewood, to name a few. Manitoba has nearly 75,700 square kilometres or 11.6% of its natural regions designated as special areas, forest preserves, or wildlife areas, although currently 3,546 square kilometres or 0.6% meet the definition set out by the World Wildlife Fund Canada.

Manitoba's Special Areas

Category	Number	Hectares
Parks		
National	1	297,604
Provincial[1]	151	1,431,667
Municipal		not available[2]
Ecologically Significant Areas		
Ecological Reserves[3]	12	56,882
Voluntarily Protected	14	9,776
Canadian Heritage River	1	200 km
Heritage Resources		
National Historic	8	
Provincial Heritage	52	not available[4]
Municipal Heritage	178	
Total Area[5]		**1,795,929**

1. See Wildlife for listing of major provincial parks.
2. A summary of municipal park areas is not available.
3. See Wildlife for descriptions of ecological reserves.
4. Total area not cited since most heritage resources occupy relatively small areas.
5. Total area excludes heritage resources and our heritage river.
Source: Manitoba Natural Resources

Demands for more recreational opportunities and resource extraction have stepped up pressures on Manitoba's parks, heritage resources, ecologically significant areas, and heritage rivers. But as interest in resource conservation grows and land becomes increasingly valuable, the preservation of undisturbed areas will become more and more critical to society's physical and social well-being.

Parks

Parks in Manitoba fall in three general categories: national, provincial, and municipal.

National

Riding Mountain, in the western part of the province, is Manitoba's only national park. It has been called an island of wilderness in a sea of farmland with golden waves of grain at its shores. When La Verendrye visited the area in the late 1700s and saw the "mountain" looming up from lush grasslands in an autumn haze, he referred to it as "the blue jewel."

Provincial Parks

Manitoba's provincial park system comprises 151 park areas, including natural, wilderness, heritage, and recreation parks, recreation trailways, parkways, waterways, and wayside parks. Provincial parks offer a wide range of recreational experiences, contribute to tourism, and encompass a variety of geographic features, plant and animal habitats, and cultural and historic resources.

Traditional forms of recreation, such as cottaging, camping, hiking, fishing, and canoeing, continue to top the list of popular recreational activities in our provincial parks. Attendance records show that park use rose through the 80s, with vehicle attendance increasing from 1,150,000 in 1980 to 1,500,000 in 1989.

Parks are managed in keeping with the following objectives which they are expected to meet:

- represent and conserve Manitoba's natural landscapes
- preserve Manitoba's cultural heritage
- serve as a haven for unique or rare and endangered species
- meet the recreational needs of Manitobans and visitors.

Provincial parks are found in four of Manitoba's five natural regions. There are currently no provincial parks in the Northern Transition/Tundra Region, but plans are under way to ensure that future park development is representative of all areas of Manitoba.

One of the most outstanding parks in the provincial system is Spruce Woods Provincial Heritage Park. It was established in 1964 to protect an unique area of rolling sandhills and natural beauty. This tract of land was formed 12,000 years ago when the Assiniboine River emptied into glacial Lake Agassiz, depositing sand and gravel in the delta area. The sandy deposits were exposed as water levels dropped and were whipped by winds into dunes 6 to 30 metres high.

Today, Spruce Woods is a place of shifting sand dunes, oxbow lakes, pots of quicksand, blue-green springs, rolling prairie, and stands of spruce and basswood. Here you can follow trails blazed by naturalist Ernest Thompson Seton in the late 1800s. The park is home to the barrel cactus, prairie crocus, bearberry, creeping juniper, and white spruce. Some of Manitoba's uncommon wildlife live in the sand: hognose snakes, plains spadefoot toads, northern prairie skinks, and tiger beetles.

Municipal Parks

One or more municipal parks are found in virtually every municipality and local government district. Most municipal parks are recreation-oriented, with playgrounds, swimming pools, and arenas. The preservation of natural and cultural features is generally not a priority, although there are notable exceptions such as Stonewall Quarry Park and the Beausejour Glass Works Historic Site.

Riding Mountain National Park. Dedicated to the people of Canada, the nearly 300,000 hectare park is a mosaic of forests, prairie, rolling hills, valleys, and crystal clear lakes and streams on a plateau that forms part of the Manitoba Escarpment. The lower slopes of the escarpment support stands of eastern deciduous forest – the elm, ash, and oak that are more commonly seen along the shores of the Great Lakes. The western-most sections are covered with grasslands and windswept meadows of rough fescue prairie, some of the last in the country. The park's wildlife population includes herds of elk, moose, white-tailed deer, wolves, and the occasional cougar, a rare predator on the Manitoba scene. Its wild streams and lakes are home to beavers, herons, and eagles. The park boasts historic artifacts and sites relating to Natives' activities in the area.

Atikaki Provincial Wilderness Park lies in the heart of a wilderness area that stretches from the shores of Lake Winnipeg to the Ontario border. Rugged jack pine forests, granite outcrops, glassy lakes, remote rivers – this roadless wilderness lies beyond the reach of acid rain and the roar of chainsaws.

Parks and People

Conflicts between recreational park users and increasing demands for resource extraction are two major sources of stress in parks. With a great variety of outdoor experiences desired by park users, recreational activities often conflict. At the same time, as extractable resources are depleted and new demands created, natural resources in parks, such as timber, minerals, and hydroelectric potential, are becoming increasingly valuable.

Since the early 1960s when the provincial park system was established, Manitoba's parks have been managed primarily as multiple use areas supporting a variety of recreational and industrial activities. A recent report of the Federal/Provincial Parks Council concluded that Manitoba's policy on resource extraction in provincial parks is one of the most permissive in Canada.

The Parks Branch supports a range of projects and programs to safeguard our provincial park resources. Here are several examples of current projects. Limits are set on numbers of boats stored in lakes in backcountry areas, such as the one in Whiteshell Provincial Park, to protect the quality of recreational experiences and fish populations. Caribou studies identifying sensitive caribou habitats within allocated logging zones on the east side of Lake Winnipeg are carried out cooperatively by Natural Resources and Abitibi-Price Inc. A program for inspecting sewer and water systems was set up in Whiteshell Provincial Park in 1988 to protect lakes and streams.

In federal parks, resource extraction is generally not permitted. In municipal parks, which are recreation intensive, resource extraction does not normally occur.

New Parks

As pressures on current park resources increase, it is important that new parks continue to be established. Manitoba's provincial park system has grown from four provincial parks and 40 recreation areas in 1962 to 16 major parks and 44 recreation areas. As well, we have about 90 small wayside parks, most less than 2 hectares in area.

Fifteen new provincial parks have been proposed. The Nueltin/Thlewiaza River area in northwestern Manitoba has the potential for a wilderness park. The Gypsumville karst area in the Interlake is another candidate park.

In 1989, the federal and provincial governments and the community of Churchill began a joint study to determine the feasibility of a new national park in the Churchill area. The federal government also expressed interest in creating a new national park in the Interlake.

Legislation

The National Parks Act protects resources in federal parks, with stiff penalties for resource violators, mandatory management plans, and authority to designate wilderness areas.

Provincial parks are protected under The Provincial Park Lands Act which is currently under review as a result of public awareness and new demands on the environment and economy.

Municipal parks are protected under local municipal bylaws.

System, Park Management, and Marketing Plans

Management plans and a system plan form the basis for park development and direct where new parks should be established.

The *Riding Mountain National Park Management Plan*, which was updated and approved in 1987, determines the future of the park. It establishes park objectives and purpose, zoning, resource conservation and management, and interpretive and visitor services.

A System Plan for Manitoba's Provincial Parks guides the creation of new parks and the management of existing ones. The plan is designed to strike a better balance among resource preservation, recreation, and commercial harvest; afford greater protection of unique or rare species of plants and animals; and achieve better representation of Manitoba's cultural heritage and natural landscapes.

As required by the overall system plan, management plans for individual provincial parks are continually being developed. Plans for Whiteshell, Hecla/Grindstone, Grass River, and Turtle Mountain provincial parks have been completed, and planning for Spruce Woods Provincial Heritage Park started in 1989. Plans for eight other major parks are still to be prepared. With the help of public input, park management plans provide overall direction for land use and development, help resolve potential land-use conflicts, establish land-use zones in parks, and identify opportunities for development. Management plans are also designed to protect park's unusual features, manage wildlife, and achieve full tourism potential.

Interim management guidelines, which direct activities in some of our provincial parks until a management plan can be completed, are also developed and updated regularly. Interim management guidelines have been approved for Nopiming, Grand Beach, Duck Mountain, and Clearwater provincial parks, and are being prepared for Birds Hill Provincial Park. Guidelines are still required for four major provincial parks.

A 3-year Marketing Plan for Manitoba Provincial Parks, completed in 1989, seeks to improve the quality of park experiences. The plan is based on surveys asking consumers for their preferences, attitudes, and opinions on campground design features, cottage subdivisions, and park programs.

Cooperation

At Riding Mountain National Park, resource management policies for the park often differ from those for surrounding communities. The Riding Mountain Regional Liaison Committee, with representatives from neighbouring municipalities as well as the federal and provincial governments, has been set up to streamline communications. Another group, Riding Mountain Park Plus People Inc., works on projects that complement park policy in Riding Mountain National Park.

People, non-profit organizations, and interest groups can become more involved in projects to enhance and promote parks and heighten the understanding of natural and cultural heritage through the Cooperative Activities Program.

Cooperating associations are also gaining prominence. Volunteers do a terrific job of expanding and developing programs that cannot always be handled by park employees.

The Friends of Spruce Woods Inc. is a cooperating association that helps the Parks Branch by providing local people with opportunities to further educational and interpretive programs in Spruce Woods Provincial Heritage Park. The Friends host interpretive hikes for high school students, produce and sell promotional materials on the park, and operate a bookshop and museum of culture and natural history. They have made improvements to the equestrian campground, and have started stabilizing the property used until 1960 by the Criddles, a legendary local family.

Similar cooperative associations are active in Whiteshell and Hecla provincial parks. Other cooperative projects begun in 1989 with support of various organizations include the Peace Trail in Birds Hill Provincial Park, biathlon trails in Whiteshell Provincial Park, and an extension of the Spirit Rock Trail in Grand Beach Provincial Park.

Interpretive Services

Interpretive programs build strong public understanding and commitment to conservation programs, encourage thoughtful use of recreational resources, and promote respect for and protection of natural and cultural resources. Riding Mountain National Park offers a full program of interpretive services, as does the provincial Parks Branch. *A Strategy for Interpretation in Manitoba's Provincial Parks*, developed in 1989 for implementation over the next 10 years, outlines management and development strategies for interpretation programs, evaluates the interpretive potential of parks, and priorizes parks according to the level of interpretation that should occur at each site. Interpretive centres will be established at key parks like Spruce Woods, Hecla, Whiteshell, and Birds Hill.

The Friends of Spruce Woods, a cooperating association, organizes and run Pine Fort Days with help from the Muzzle Loaders Association. The event, which features a pancake breakfast, attracted more than 500 visitors in 1989.

Ecologically Significant Areas

Ecologically significant areas preserve unique and rare natural features, rare or endangered plant and animal habitats, and examples of natural and modified ecosystems for study, research, education, and aesthetic benefit. These special areas are protected through designation as ecological reserves or voluntarily protected ecologically significant areas.

Ecological reserves are set up on Crown land and protected under The Ecological Reserves Act. Voluntarily protected ecologically significant areas are set up on private or designated Crown land in cooperation with landowners who want to preserve significant areas but still own the land. Responsibilities for voluntary protection are spelled out in a non-binding agreement between the landowner and Manitoba Natural Resources.

Both types of areas protect genetic resources, allow natural genetic variations to continue, and provide a setting for long-term research unhampered by man or conflicting uses.

Ecological Reserves

In 1976, Reindeer Island became Manitoba's first ecological reserve. The 142- square-kilometre island in Lake Winnipeg is 32 kilometres north of Anama Bay and directly west of Berens River. The island, the most southerly extent of permafrost, supports several boreal plant and animal communities, including the American yew and boreal chorus frog. Logging, hunting, trapping, and development are prohibited. Although only educational and research activities are permitted, a small section of a beach and a sand spit on the northeast shore of the island has been set aside as a harbour of refuge for small craft during rough weather.

For ecological reserves to remain high-quality research and monitoring sites, they must be left alone so that all natural influences are free to operate unhindered. Some people want to open reserves for hunting and trapping, but this would introduce stresses that could throw off subtle balances in the overall ecosystem.

New ecological reserves come on stream slowly – roughly one a year. The proposed provincial system of ecological reserves, when completed, will ensure that three representative examples of all major provincial ecosystems are rigourously protected. One example is for research, one for education, and the third for backup. No intensive recreation, building, or other consumptive uses are allowed. The reserves are open to activities such as birdwatching and photography.

One of our next ecological reserves could be set up to protect four caves in the Interlake. The caves feature calcite crystals and goethite. One of them, Bat Cave, contains the most outstanding examples of fragile "flowstone drapery" and "soda straws" known in Manitoba. Bat Cave provides a haven for up to 7,000 bats that overwinter in the cave, making it the largest known bat hibernaculum in Manitoba. The little brown bat is the primary inhabitant although keens bats may also use the cave. In summer, bats leave the cave to forage for insects, the mainstay of their diet. In winter, when the bats hibernate in the depths of the caves, they require protection from disturbances that could cause them to use up precious energy reserves, threatening their survival.

Ecological reserves are protected under The Ecological Reserves Act (*see* **Wildlife**) and managed under the terms of a program description that sets out the background, goals, objectives, and components of the reserve. Compiled in 1987, the program description links ecologically significant areas to the World Conservation Strategy which, in part, stresses the need to protect genetic diversity, unique and representative ecosystems, and habitats of threatened and unique species.

Voluntarily Protected Ecologically Significant Areas

The voluntary protection of ecologically significant areas by private citizens on private land and by land administrators on designated Crown land is a vital aspect of the Ecologically Significant Areas Reserves Program. In 1990, four new voluntarily protected areas were enrolled in the program: the Gilles property near Gimli, the Forrester and Schellenburg properties near Altona, and the Sopuck property near Riding Mountain. All sites have seen little or no disturbance and support a wide variety of plant species, including prairie lily, Indian paintbrush, and yellow lady's-slipper.

Bat Cave in the Interlake, home to several species of bats, and one of four caves that could form a new ecological reserve.

Bluestem Nature Park. Located along Omands Creek in Winnipeg, the park preserves a patch of native prairie in the midst of the city. It was built with sod moved, piece-by-piece, from the corner of Wellington and Berry streets where the Radisson Suite Hotel now stands. The park is home to at least 200 species of native plants, 6 species of small mammals, 70 species of birds, and 20 species of butterflies.

Protecting Endangered Ecosystems

Tall-grass prairie once dominated the landscape in southern Manitoba. Today, it is the most threatened ecosystem in North America.

Manitoba is the only western Canadian province where tall-grass prairie once grew and where now, only meagre remnants remain. Agriculture, fire suppression, and urban development share the responsibility for its demise. In just 100 years these forces have virtually eliminated a local ecosystem that existed here for almost 10,000 years.

In 1987, The Tall-Grass Prairie Conservation Project, an activity of the Manitoba Naturalists Society, compiled the first inventory of tall-grass prairie communities in Manitoba. Goals of the project are to locate, protect, and manage all relict sites, and educate landowners, resource managers, and the general public on the value and management of tall-grass prairie.

Recently, 300 hectares of tall-grass prairie were set aside south of Steinbach in the Tolstoi-Gardenton area. Unique in Canada, it has never been farmed and is the largest piece of tall-grass prairie in the province.

The Bradley Prairie, at the corner of Bradley and Regent in Transcona, protects 5 hectares of "best quality" tall-grass prairie from development in the area. Other sites of tall-grass prairie are Oak Hammock Marsh (nearly 60 hectares), Beaudry Provincial Heritage Park (less than 5 hectares), and the Living Prairie Museum (about 13 hectares) in Winnipeg.

Canadian Heritage Rivers

Created in 1984, the Canadian Heritage Rivers System is a joint federal/provincial/territorial program designed to protect the great rivers of Canada. A river is picked for designation as a Canadian heritage river because of its natural beauty, outstanding history, or recreational qualities like canoeing and fishing. If it becomes a heritage river, it is managed so that none of its outstanding qualities are lost, for the long-term benefit of Canadians and visitors to Canada.

In 1987, the Bloodvein River became Manitoba's first heritage river. Protected by its location in Atikaki Provincial Wilderness Park, the Bloodvein is a classic wilderness canoeing river, with rapids, falls, and wild twisting sections at its headwaters, to peaceful flows past quiet lakes and wild rice marshes along its lower reaches. One of Canada's finest wild streams, it flows through matchless shield scenery alive with moose, black bear, timber wolves, river otter, lynx, and fisher. The river primarily appeals to white-water canoeists or those seeking a remote wilderness experience.

The Bloodvein is currently Manitoba's only heritage river, but several contenders are up for designation. In 1987 the Seal River was nominated to the system, and the Parks Branch has completed a background study to assess the suitability of the Hayes River as a candidate for the system.

As in other special areas, the ability of the heritage rivers system to conserve natural, historical, and recreational values is influenced by developments in surrounding areas. On the Bloodvein, greater access through road construction and transmission lines has led to demands for outcamps and hunting. On the Seal, mining and hydroelectric developments would threaten the river's character. These factors must be carefully evaluated to make sure that the Bloodvein and other rivers that may be designated as heritage rivers remain the great wild rivers that they are.

Although heritage rivers are designated by the Canadian Heritage Rivers Board, their management is the responsibility of the jurisdiction in which the river flows. In Manitoba, because the Bloodvein is in Atikaki Provincial Wilderness Park, it is subject to provincial parks regulations and guidelines. Interim Management Guidelines for Atikaki Provincial Wilderness Park are currently being developed. In 1989, the Parks Branch prepared a draft management plan for the Seal for public review. Once the public consultation process is completed, the draft management plan will be presented at the Canadian Heritage Rivers Board Meeting. Acceptance of this plan is the final step in designating the Seal as a heritage river.

The Seal, considered by some as Manitoba's 'ast great wild river, is up for designation as a Canadian heritage river. A swift-flowing river in a subarctic setting, the Seal offers a true wilderness experience – challenging stretches of boulder rapids (not for novice canoers; a spill in the icy waters could be serious), fabulous fishing, and chance encounters with seals, wolves, and barren-ground caribou. At the mouth of the river on the southwest shores of Hudson Bay, is one of the world's best calving grounds for the beluga whale.

The Bloodvein, Manitoba's first Canadian heritage river. To qualify for this distinction, a river must be of outstanding significance in one or more categories: human heritage, natural heritage, or recreational values. The Bloodvein qualifies in all three.

Looking Back

Trails

Manitoba's early pioneers reached their new homes by following trails created over the centuries by bison herds, Natives, and fur traders. Settlers often chose plots of land that were within easy reach of trails. With the coming of the railways, many of the developing communities along the trails were abandoned or moved closer to the newer transportation network.

The Boyne Marsh

Today the area southwest of Winnipeg, bordered by Starbuck, Carman, and Sanford, is prime agricultural land. It was passed over by the early settlers of Manitoba because it once formed a huge wetland known as the Boyne Marsh. Government drainage efforts began in 1880, and technically the area was considered ready for agricultural production by 1907. But as late as the 1920s, when the land was bought by Mennonite families, it was still very wet.

The Boundary Commission Trail

Outside Deloraine, near Turtlehead Creek, you can still find part of the Boundary Commission Trail where the members of the Boundary Commission survey team camped during their expedition in 1873. Three hundred members of the North West Mounted Police from Fort Dufferin, near Emerson, stopped here in 1874 on their trek westward to maintain order among the Natives in the foothills of the Rockies and to suppress the whiskey trade operated by American traders.

Salt-Making in Manitoba – The Untold Story

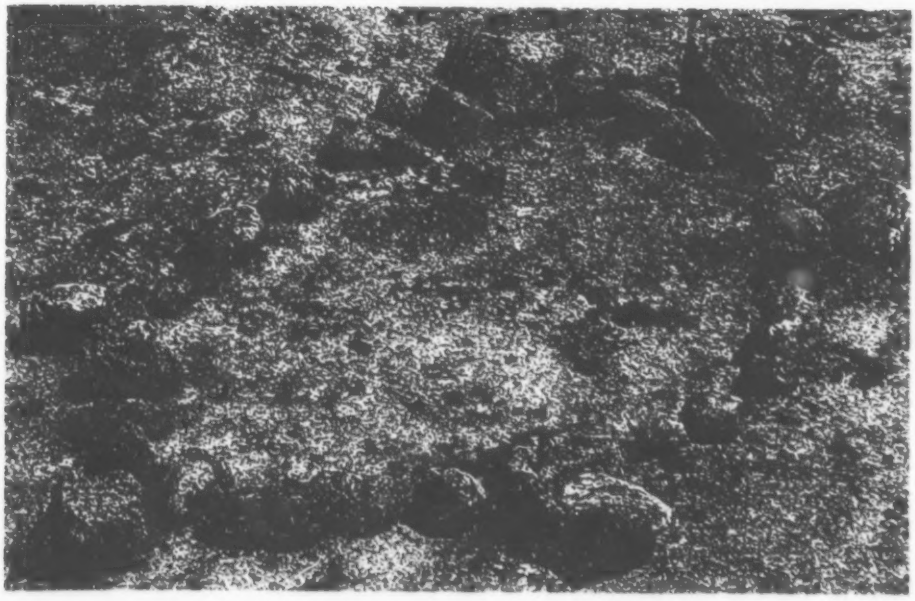
Aside from the fur trade, salt-making was probably Manitoba's first industry and one that has been overlooked.

Salt springs in the province were used by Natives, fur traders, Métis, and later, industrialists.

The earliest record of salt-making in Manitoba is found in the journals of La Verendrye, who in 1738 was presented with a gift of salt by local Natives. Various fur traders on the Red River and in the Swan Lake/Lake Winnipegosis area made salt regularly for their own use. Later, Joseph Monkman, a Scots-Métis, carried out a successful enterprise, supplying the Red River Settlement with salt from about 1818 to 1874.

Attempts at creating a competitive industry continued until 1970, when the Canada Salt Company in Neepawa folded.

Red ochre and fish oil were used to paint pictures hundreds of years ago. Known as "pictographs," they were painted by prehistoric Indians and their descendants. Rock paintings are a fragile heritage resource.



Petroforms in the Whiteshell. Constructed by Natives nearly 1,000 years ago, these stone mosaics of turtles, serpents, and other symbols are thought by archaeologists to have influenced the creation of medicine wheels in other parts of Canada and the United States. Under The Heritage Resource Act it is illegal to collect, move, or alter objects or artifacts of archaeological significance without a permit.

Heritage Resources

Heritage resources are works of natural or human endeavour that have historic, cultural, natural, or aesthetic value. They are the record of past events, written into the landscapes of Manitoba.

Ancient stone tools such as arrowheads and scrapers, fossils, human occupation sites, landscapes, buildings, and structures are examples of heritage resources. In the Northern Coniferous and Broadleaf/Mixedwood Forest regions, small, shelled marine animals and corals are preserved in limestone outcrops. Large marine reptiles such as plesiosaurs and mosasaurs are preserved in thin beds of clay near Morden in the Grassland Region. Spear points perhaps 11,000 to 12,000 years old have been found in the Grassland and Broadleaf/Mixedwood Forest regions. Evidence that Native people grew corn in Manitoba from 500 to 800 years ago has been discovered at Lockport.

Sites of European exploration and commerce are found throughout the province and evidence of settlement, urbanization, and industrialization abounds. Many of our old buildings have historic significance and are an undervalued resource. Replacing them would cost about $48 billion based on estimates by Statistics Canada.

Inventory

Only a small portion of Manitoba has been inventoried for potentially significant heritage resources, and an even smaller portion of the resources has been protected by the province. At the provincial and municipal levels, 220 of 232 protected sites are structures, with 151 located in Winnipeg.

Captain Kennedy House, on River Road in St. Andrews municipality, was the home of Captain William Kennedy and his family in the late 19th century. Active in the trade business between England and Manitoba, Kennedy was a local magistrate and served on Manitoba's Board of Education. His wife, Eleanor, was community minded, nursing the sick, distributing food and clothing among the needy, and teaching music to the young ladies at Miss Davis' school. She helped support the family with her millinery and dressmaking and by importing European fashions. Today, the house is furnished in the period styles of the 1870s and 1880s.

Delorme House, in St. Norbert Provincial Heritage Park, is a one-and-a-half storey, log and clapboard house built by Pierre Delorme in the mid 1850s. Delorme was an ally of Louis Riel's and worked for the rights of the Métis. He was Justice of the Peace for St. Norbert, an elected member for St. Norbert South, a member of Parliament for Provencher, Minister of Agriculture, and an executive of the North West Council. The house is a symbol of pre-1870 Red River society and the struggle of the Métis to retain their culture and land rights.

Cultural resources of national significance are owned and protected by the federal government as national historic sites or parks. Eight areas have been designated to date, including Lower Fort Garry National Historic Park near Selkirk, Prince of Wales' Fort National Historic Site near Churchill, and The Forks National Historic Site in Winnipeg.

Irreplaceable

Heritage resources can never be replaced if lost or destroyed. They can be destroyed by land clearing, development, site excavation, erosion, and the activities of unknowing or uncaring individuals.

The movement of people out of rural areas has greatly increased the number of unoccupied and under-utilized buildings in rural Manitoba. Some of those pioneer buildings are very important but when left vacant or neglected, they rapidly deteriorate until it is no longer feasible to preserve or restore a representative sample of them.

Pressure for new construction, the trend toward higher housing densities, and demand for maximum returns on investments have spelled the end of many older buildings in urban areas. The problem is compounded by limited incentive programs for encouraging reuse and preservation.

Taxes can have a negative effect on heritage resources. If the land is still zoned agricultural, the landowner is pressured to have it zoned residential and subdivided. If the land is already zoned residential, taxes rise after it is subdivided. Much of the farmland in and around Winnipeg, for example, has been taken up by housing developments because the land was taxed on its value for housing rather than for agriculture. Development of this land can destroy valuable heritage resources besides consuming farmland.

Spotlight on Heritage Resources

Old Pinawa Dam Site, R.M. of Lac du Bonnet

The Pinawa Power Dam is the site of Manitoba's first hydroelectric generating plant on the Winnipeg River. Built at the beginning of the century, it operated year-round, supplying Winnipeg and surrounding communities with electricity from 1907 until 1951. The site was abandoned in 1951 so that the full flow of the Winnipeg River could be restored to the main channel of the river for better use by the Seven Sisters development. Parts of the structure have been blasted away, a legacy of the years when the site was used for demolition practice by the armed forces.

From 1973 onward, proposals were put forward to create a recreational park around the ruins of the former industrial site. In 1982, a local task force began the push to have Pinawa Dam declared a provincial heritage site. The Parks Branch developed the area into a recreational park that opened in 1985.

Today you can fish for pickerel off the top of the dam, wander through the ruined superstructure (there are railings to keep you out of trouble), or take a canoe below the dam and explore the echoing penstocks where the waters of the channel once roared.

Stonewall Quarry Park, Stonewall

Begun in 1879/80, the Stonewall quarries provided employment and materials for early settlers to Manitoba. Several quarries were located east and north of town, producing lime and rubble for constructing house foundations. After 1881, when the railway made Stonewall the chief supplier of lime and building stones, the quarries greatly contributed to Winnipeg's building boom. The last kiln ceased operation in 1968.

Reclamation of the dug-out studded landscape began in 1959 with the creation of a man-made lake and beach north of town. In 1981, the town of Stonewall purchased the former quarry site on the edge of town and work began on interpreting the old workings with the help of pathways, outdoor signage, a small amphitheatre, and a large visitor centre.

Today Stonewall Quarry Park takes visitors back to the early industrial history of the area and includes displays on Manitoba's natural and prehistoric past.

Grand Rapids Tramway, L.G.D. of Grand Rapids

In 1877 the Hudson's Bay Company built a small railway at Grand Rapids to transport its furs and supplies from steamers on Lake Winnipeg to steamers on the Saskatchewan River. The first tramway in western Canada, it was a system of iron rails and horse-drawn cars that eliminated a back-breaking, time-consuming portage past the large rapids that formed a transportation bottleneck at the mouth of the Saskatchewan.

The decline of steamships, in favour of the railways, caused the tramway to be abandoned after 1903. The old tracks were hidden by bush until 1983 when local people started a drive to create a park at the site and rebuild the remaining portion of the tramway, using iron rails salvaged by Manitoba Hydro during construction of the Grand Rapids Dam in 1961. The Grand Rapids site was recommended as a site of historical significance in 1985 and a plaque commemorating its construction was erected by the province in 1987.

Manitoba Glass Company, Beausejour

Because of the fine silica sand located there, the Manitoba Glass Company was established in the Beausejour area in 1906. Experienced workers were brought from Europe and across North America to manufacture amber and pale green bottles for the western Canadian market. At its peak, the factory employed up to 400 people and ran three shifts.

In 1913, a price war forced the sale of the Manitoba Glass Company to a larger eastern firm, a phenomenon that was commonplace all across Canada as large factories forced the closure of small local industries. The plant was closed in 1913 and for a while stood intact. Eventually all salvageable materials were sold and the bricks carted off for local uses. What remained was industrial waste, old foundations, and remnant furnaces.

When the glass factory property was put up for sale in 1987, the R.M. of Brokenhead, the town of Beausejour, and a local historical society made arrangements to form a non-profit corporation to buy the site and develop it, with help from a grant from Lafarge Canada, Ltd.

The former factory site was designated a provincial heritage site in 1989. The Manitoba Glass Works Historic Site, Inc. continues to work on its plans, which include an interpretive centre, a museum display, and glass-blowing demonstrations.

Legislation

The Manitoba Heritage Resources Act, the federal Historic Sites and Monuments Act, and the City of Winnipeg Historical Buildings By-law 1474/77 and Zoning By-law 4800 are the principal pieces of legislation that protect provincial, municipal, and national heritage sites.

The Heritage Resources Act was drafted in response to growing public awareness of the importance of our heritage resources and the pressures on them. The Act allows for heritage resource impact assessments, establishes a public review process for designation, and encourages people and groups to get involved through grants and assistance programs. Assessments ensure that proposed alterations and developments are screened to determine their effects on heritage resources, and that the people involved complete the necessary impact assessments and mitigation. And a first – the Act gives municipal governments the power to set up heritage advisory committees, designate heritage sites, and offer educational programs.

The Historic Sites and Monuments Act covers the commemoration of historic sites and the formation of the Historic Sites and Monuments Board which administers, preserves, and interprets historic places. The federal government can commemorate sites with heritage site markers, enter into cost-sharing agreements with the property owners for the restoration of unique nationally significant sites, or acquire and operate some sites and parks.

The federal government is currently studying the need for legislation to preserve and protect heritage resources on federal land and on land affected by federally funded projects. The Federal Heritage Buildings Review Office is responsible for identifying and preserving federally owned buildings.

The Railway Station Preservation Act is designed to cover the preservation of heritage railway stations still owned by rail companies.

The City of Winnipeg Historical Buildings By-law 1474/77 allows for the evaluation of properties by the Historic Buildings Advisory Committee and the protection by Council of buildings by placement on the Buildings Conservation List. What is now referred to as The Exchange District in Winnipeg first became a protected area in 1978 with the passing of the Historic Winnipeg Restoration Area By-law 2048/78. In March 1988, the Historic Winnipeg Restoration Area By-law was replaced by the Downtown Winnipeg Zoning By-law 4800. Under this new bylaw the Historic Winnipeg Advisory Committee reviews all developments in The Exchange District.

Preservation Programs

Under The Heritage Resources Act, several preservation programs have been launched since 1986. The Manitoba Heritage Council reviews heritage resource sites and recommends which ones should be designated as provincial heritage sites. Fifteen municipal heritage advisory committees have been formed to make recommendations to municipal councils on heritage issues and, in particular, the designation of municipal heritage sites.

Since 1986, 27 provincial and, outside of Winnipeg, 44 municipal heritage sites have been designated. Winnipeg has listed 138 structures and created a heritage conservation district – The Exchange District – under its zoning bylaws.

Other heritage resource programs include the provincially and municipally designated buildings grants that help owners and renters preserve designated buildings, and the commemorative plaque program that acknowledges sites of provincial significance. Community commemorative plaque grants help fund commemorating events, subjects, themes, or places of local historic significance. *The Thematic Structure of Manitoba History* is an organizing framework to streamline systematic preservation and interpretive planning.

The Manitoba Archaeological Volunteer Regional Advisers monitor heritage resource sites and development activities in their respective regions and pass on information to Manitoba Culture, Heritage, and Citizenship. Municipal heritage advisory committees identify and evaluate heritage resource sites in municipalities and assist municipal councils.

Important educational components for heritage resources are interpretive plaques, publications, teaching kits, television vignettes, workshops, and archaeological excavations where the public is invited to lend a hand.

The childhood home of Margaret Laurence in Neepawa was in danger of demolition a few years ago. Today, the local community has given the house a new lease on life by turning it into a museum, art gallery, and studio space. Built at the turn of the century, the house was designated as a heritage site by the province in 1987. With the assistance of various grants, including a Heritage Building Grant, the brick house is now a key tourist attraction and community cultural facility.

The Recycling Advantage

"Recycling" heritage buildings gives tourism a boost, opens up investment opportunities, brightens urban areas, and serves as a source of community pride. It can also offer a surprising range of economic advantages.

The practice reduces the continual depletion of scarce natural resources. Some 25% of the cost of recycling an old building is for new materials, in contrast to 50% for new materials in a new building of equivalent size and cost. The remainder of the building cost is for labour.

Renovation projects are typically one-and-one-half times more labour intensive than new construction, giving local employment a boost.

Renovating a historic building consumes up to 25% less energy than is required to construct an equivalent new building.

Demolishing an old brick house – as opposed to renovating it – produces between 50 and 90 tonnes of waste. While figures are not available for Manitoba, in Ontario about 16% of all landfill waste comes from the construction industry and roughly 14% of that is from the demolition of potentially useful buildings.

The recycling of land, despoiled by mining and industrial development, is a recent phenomenon in Manitoba. By recognizing the potential recreational and tourism value of such former industrial sites as the Stonewall Quarry and the Glass Factory at Beausejour, and reclaiming the land, Manitobans are preventing the loss of valuable agricultural and natural lands.

Miles of abandoned railway lines in the province offer opportunities for redevelopment as recreational paths for hikers, cyclists, and snowmobilers, as well as possible reuse as roads and bus lanes.

In the early 1980s, people in Virden raised funds to preserve the Auditorium, once a fine performing arts theatre built in 1911. As a result of their efforts, the building once again serves as a cultural touchstone in the community. The town also received $75,000 under the Heritage Buildings Grants Program to rehabilitate the Municipal Building, which had been built in the same year as the Auditorium. Both buildings form part of a fully modernized multiple-use facility that serves as a focal point for many community functions.

Legislation Alone Not the Answer

Manitoba's special areas contain valuable and irreplaceable natural, cultural, and heritage resources. Most areas are protected by acts, principally the National Parks Act, The Provincial Park Lands Act, The Historic Sites and Monuments Act, The Heritage Resources Act, and The Ecological Reserves Act.

The Manitoba Environment Act, which became law in 1988, indirectly protects special areas by addressing pollution control, non-polluting environmental damage, licensing, enforcement, and public consultation and participation.

It takes more than legislation to protect our special areas. Conservation and management programs, volunteer programs, and educational programs help shield special areas from environmental stress. Volunteer programs involving liaison committees, cooperating associations, and citizen advisory groups are lending a hand with resource management. Educational and interpretive programs, complemented by publications, films, videos, and the media, help build public support by increasing our understanding of the importance of preserving special areas to our physical and social well-being.

In Manitoba, several groups have formed the Wilderness Caucus to promote protected areas such as the proposed national park near Churchill, and the Endangered Spaces campaign. The Manitoba Naturalists Society has taken the lead in organizing this ground-breaking effort, arranging meetings with ministers, distributing the book *Endangered Spaces*, and collecting thousands of signatures for the Canadian Wilderness Charter. The effort of the Wilderness Caucus is a cooperative one, with input from the Brandon Natural History Society, Manitoba Environmentalists Inc., Manitoba Forestry Association, Wildlife Foundation of Manitoba, Manitoba Recreational Canoe Association, Manitoba Wildlife Federation Inc., Marquis Project, Earth Day Committee, Sierra Club, Westman Wilderness Club, the Wildlife Society, Manitoba Environmental Council, University of Manitoba Environmentalists, and the Conservation Strategy Association of Manitoba.

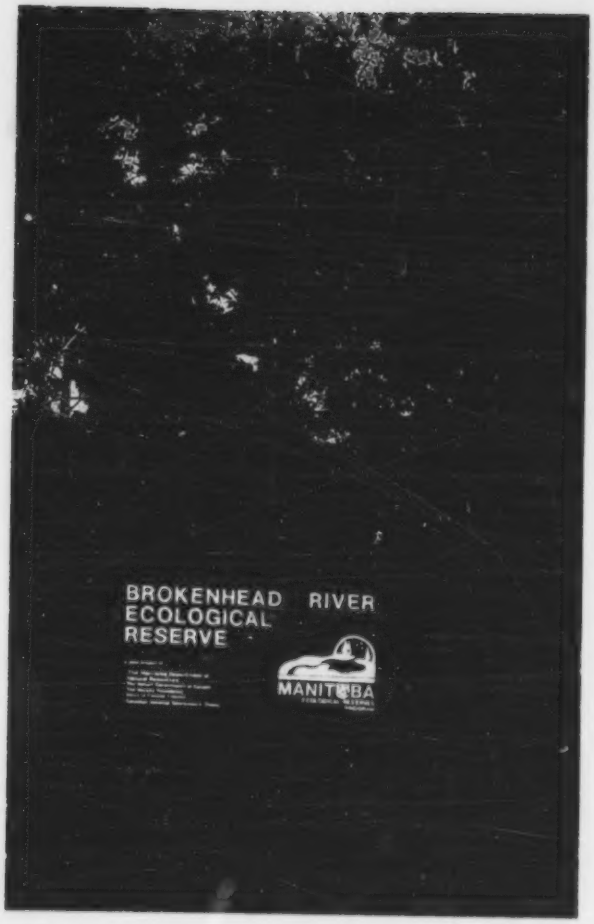
ACTIVITIES ALLOWED IN SPECIAL AREAS

	Research	Recreational Access	Cottage Development	Sport Fishing	Commercial Fishing	Licensed Hunting	Outfitters/Outcamps	Trapping	Subsistence	Farming	Grazing	Haying	Wild Rice Harvesting	Hydroelectric Development	Logging	Mining
National Parks	✓	✓	Ø[1]	✓	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
Provincial Parks - Natural	✓	✓	≈	✓	≈	✓	✓	✓	✓	≈	≈	≈	≈	Ø	≈	≈
Provincial Parks - Wilderness	✓	✓	≈[1]	✓	≈	✓	✓	✓	✓	Ø	Ø	Ø	✓	Ø	Ø	✓
Provincial Parks - Recreation	✓	✓	≈	✓	≈	✓	≈	✓	✓	≈	≈	≈	Ø	Ø	≈	≈
Provincial Parks - Heritage	✓	✓	Ø	✓	≈	≈	≈	≈	✓	≈	Ø	≈	Ø	Ø	Ø	≈
Provincial Parks - Wayside	✓	✓	Ø	✓	Ø	✓	Ø	✓	≈	Ø	Ø	≈	Ø	Ø	Ø	Ø
Municipal Parks [2]																
Ecological Reserves	≈	≈	Ø	Ø	Ø	Ø	Ø	Ø	≈	Ø	Ø	Ø	Ø	Ø	Ø	Ø
Voluntarily Protected Ecologically Significant Areas [3]	≈	≈	Ø	≈	≈	≈	Ø	≈	≈	Ø	Ø	Ø	Ø	Ø	Ø	Ø
Canadian Heritage Rivers	✓	✓	≈[1]	✓	≈	✓	✓	✓	✓	Ø	Ø	Ø	✓	Ø	Ø	≈
Heritage Sites	≈	≈	≈	†	†	≈	≈	≈	≈	≈	≈	≈	†	Ø	Ø	Ø
Provincial Forests	✓	✓	≈	✓	✓	✓	✓	✓	✓	Ø	≈	≈	✓	✓	✓	✓
Wildlife Management Areas	≈	✓	Ø	✓	✓	≈	≈	≈	≈	≈	Ø[4]	≈	Ø	≈	≈	≈
Refuges [5]	✓	✓	Ø	✓	✓	≈	✓	≈	≈	✓	✓	✓	✓	✓	✓	✓
Special Conservation Areas	✓	≈	Ø	✓	✓	✓	✓	✓	✓	Ø	Ø	Ø	Ø	Ø	Ø	Ø
Heritage Marshes	✓	✓	≈[1]	≈	≈	≈	≈	≈	≈	≈[6]	Ø	≈[7]	✓	Ø	✓	≈
Military Reserves [8]	≈[9]	≈	Ø	Ø	Ø	≈	Ø	Ø	✓[10]	≈	≈	≈	Ø	Ø	≈	≈

✓ allowed in all ≈ allowed in some, or in zoned areas, or by permit
Ø not allowed
† not applicable

Notes: 1. No new cottages allowed. 2. Municipal laws apply. 3. Depends on discretion of owner. 4. Leases are not renewed. 5. Refuges address only hunting and discharge of firearms. 6. Lure crops only. 7. Allowed where traditionally hayed. 8. Limited access because of safety restrictions. 9. Only essential research allowed. 10. Not allowed during training exercises.

Source: Manitoba Natural Resources, Canadian Armed Forces



Trends

Provincial parks ——— **Better**
Manitoba's provincial parks system has grown from four provincial parks and 40 recreation areas in 1962 to 16 major parks and 44 recreation areas in 1990. There are about 90 small wayside parks and 15 new provincial parks have been proposed.

Ecological reserves ——— **Better**
Since 1973 when Manitoba's ecological reserves program got under way, 12 reserves have been established bringing the total protected area to approximately 56,882 hectares.

Voluntarily protected ecologically significant areas — Better
Enrolment in this program has increased to 14 sites totalling 9,776 hectares. The trend give some indication that people are becoming more aware of the importance of protecting special sites.

Heritage rivers ——— **Better**
Although the Bloodvein is Manitoba's only heritage river, the Seal and Hayes rivers are under assessment as candidates.

Heritage resources ——— **Better**
There is a much greater public awareness and acceptance of heritage resources than ever before. Since the new Heritage Resources Act in 1986, provincial designation of sites has doubled.

Natural land base ——— **Same**
Manitoba has nearly 75,700 square kilometres or 11.6% of its natural regions designated as special areas, although not all of them are protected under the definition set out by the Endangered Spaces Program. However, Manitoba is committed to help meet the goal of the Endangered Spaces Program, which is to preserve 12% of Canada's natural land base by the year 2000.

STORIES FROM THE FILES

The following stories were drawn from material on file at various departments throughout the provincial government. They were included to cover late-breaking environmental news, review a cross-section of controversial topics, and round out the overall report by adding items of interest that did not lend themselves to coverage in other sections.

Cross Lake Water Supply Escapes Contamination

In the early hours of December 12, 1990, a Shell Canada tanker truck carrying 9,400 litres of gasoline fell through the ice into the east channel of the Nelson River. Although the tanker was under water for the next two days, sampling shows that the river, which supplies water to the community of Cross Lake, was not contaminated by the gasoline.

The ice road across the river was not officially open when the tanker attempted the crossing. Ice thickness measured between 20 and 30 centimetres. It is illegal to use the road until the ice is at least 90 centimetres thick, usually in mid January. The tanker broke through the ice 50 metres from shore and sank in 6 metres of water. The driver escaped unharmed.

Within an hour of the incident, Manitoba's Emergency Response Team in Winnipeg was notifed. Cross Lake was advised to shut down its two water supply systems as a precaution and to use tanker trucks to supply the community from a site further upstream. The team flew to Cross Lake that afternoon with representatives from Shell Canada and two divers.

The tanker was located, divers sealed a small leak in a compartment hatch, then the tanker was towed toward shore along a channel cut in the ice by a crew from the community. It was pumped out just offshore to avoid the possibility of a rupture when the tanker emerged from the water. Seventeen barrels of contaminated snow were collected and removed from the ice, then burned off and the sludge recovered for disposal.

Samples taken downstream from the accident site and at the water supply intakes for the community during and following the incident have shown no signs of gasoline contamination. The community's water supply is now back in operation.

In northern areas, operators who travel ice roads develop a feel for the loads that can be safely transported across them. But they are quick to point out that veterans are not necessarily more knowledgeable than novices about the bearing capacity of ice. John Denison, an authority on snow and ice road construction and operation, quotes a friend of his as saying that: "The only fellow who knows anything about ice is in his first or second year working on it, because he still has some confidence left. The longer you stay with it, the less you know."

Rafferty-Alameda Continues Despite Opposition

Work on the Rafferty-Alameda dams along the Souris River in Saskatchewan continues despite lack of a court-ordered environmental impact assessment and objections from Manitoba that flows will change and water quantity could suffer if the project is built.

Manitoba is concerned that peak flows may last longer in spring, there may be reduced flows in mid summer and fall, and water quality could deteriorate.

The province has called for a scientifically defensible assessment identifying impacts on our waters from the dams in Saskatchewan. The assessment would also weigh the effects of modifications that will be required to adjust water control systems in North Dakota, the source of most of the water entering Manitoba from the Souris.

The project involves two dams, Rafferty on the Souris and Alameda on Moose Mountain Creek, a tributary of the Souris. Both dams will be operated to provide cooling water for the Shand thermal generating station, irrigation, flood control, and recreation while ensuring that Saskatchewan delivers enough water to the United States to meet international agreements.

Some critics have claimed that the reservoirs behind both dams would evaporate about half the natural flows of the Souris, raising doubts about North Dakota and Manitoba receiving their fair share of water.

The U.S. Army Corps of Engineers has bought $50 million worth of storage capacity in the project as insurance against flooding which has plagued North Dakota in recent years, particularly in the Minot area.

Saskatchewan issued the necessary internal approvals for the project, then sought approval from the federal government under the International Rivers Improvement Act since the Souris is an international navigable stream. The federal government issued a licence to build the project under this act.

When construction of Rafferty began in the spring of 1989, the Tetzlaff brothers, who own farmland that would be flooded by Alameda, went to court to get an independent public review of the project. The brothers won and the review started, but under the terms of the court order, work on the project was allowed to continue.

Meanwhile, the federal government reached an agreement with Saskatchewan that construction would be halted with the exception of safety work at the dam sites. To compensate for the delay, the federal government agreed to pay Saskatchewan $10 million a month for up to 8 months.

In the fall of 1990, frustrated by the slow federal review, Saskatchewan decided to proceed with construction. The federal government stopped paying Saskatchewan, and the federal environmental review panel promptly resigned on the grounds that further work on the dams would rule out structural modifications that could reduce or eliminate environmental impacts determined by its review.

Source: Environment Canada

The Tetzlaff brothers appealed the case, demanding that construction be halted until a full federal review could be completed. They lost the appeal.

On January 24, 1991, after part of their farm was flooded by the project, the brothers launched a federal court challenge to quash the project's licence until a full federal environmental review could be completed.

Meanwhile construction continues on Rafferty, which is almost completed, and is beginning on Alameda. Manitoba continues to work with the federal government, Saskatchewan, North Dakota, and the United States federal government to set water quality objectives on both international crossings of the Souris and develop a system for managing operation of the dams so that water quality is protected.

In a deep dam such as Alameda, water in summer tends to separate into two layers, with the bottom layer becoming stagnant. When water needs to be released in summer, it is generally from the lower, stagnant layer since most dams are built with openings near the bottom, not the top. The problem does not develop in winter because water quality is generally uniform from top to bottom of the reservoir. Discharge ports can be built at several levels in dams, to release water of better quality found near the surface in summer.

Winnipeg Gets Institute for Sustainable Development

On March 19, 1990, the province and the federal government announced creation of the International Institute for Sustainable Development, to be situated in Winnipeg.

The Institute, which has an international board of directors, is a non-profit organization dedicated to promoting the concept of environmentally sustainable economic development and integrating the principles and practices of sustainable development within and between the public, private, and voluntary sectors on a national and international basis.

It has a core operating budget of $25 million over 5 years from the Canadian International Development Agency and Environment Canada (75%), and the province (25%).

Dr. Gro Brundtland agreed to be the "first friend of the Institute." Dr. Brundtland headed the World Commission in Environment and Development which in 1987 released *Our Common Future*, a report that has become the bible of sustainable development.

Presence of the Institute in Manitoba strengthens the province's efforts to implement our own sustainable development policies, intitiatives, and programs.

Permits Impose Restrictions on Mosquito Spraying

Under Manitoba Regulation 94/88R of The Environment Act, government departments, Crown corporations, municipal corporations, and other government agencies must obtain a permit from Manitoba Environment before applying pesticides.

The permit system imposes terms and conditions, ranging from times of spraying to public notification.

Winnipeg continues to battle mosquito infestations by carrying out mosquito larviciding in the city. All chemicals used are registered and approved by Agriculture Canada. In 1989, the city's permit carried several restrictions, as follows:

- Aerial application of insecticides over private residences is not permitted.
- At golf courses, an announcement of the pesticides used, and their purpose, must be prominently displayed at tee-off shops, before and during any pesticide application carried out while golfers are using the links.
- A public announcement of the pesticides used, and their purpose, must be prominently displayed at any city park gates, before and during any pesticide application carried out while people are using the park.
- Applicant must insure that public warning signs are displayed wherever insecticides sprays could blow onto cars.
- Applicators must wear protective equipment when mixing and applying pesticides.

Several other Manitoba municipal corporations hold permits for larviciding. In Winnipeg, if larviciding does not prove effective in controlling mosquitoes, the city has the option of fogging, which is also controlled by permit.

Noise Barriers on Lagimodiere Could Set Precedent

A noise attenuation barrier erected along the west side of Lagimodiere Boulevard at Windsor Park in Winnipeg has reduced noise to the satisfaction of residents.

The barrier, which cost the province $1 million, may set a precedent for reducing noise in other areas of the city.

Lagimodiere Boulevard is a major traffic artery and truck route in Winnipeg. The east side of the boulevard is zoned industrial and is occupied by heavy industry. The west side is zoned residential/commercial and includes Windsor Park.

For years, the residents of Windsor Park have complained of noise and dust generated by traffic and industry. Following construction of the barrier, noise levels dropped from the 70 to 72 decibel range to between 63 and 64 decibels, just below the provincial guideline of 65 decibels.

The decibel is a measure of the relative loudness or intensity of sound. A 70-decibel sound is 10 times louder than a 60-decibel sound.

Getting the Lead Out

Since 1979, levels of lead in air measured in Winnipeg have been well below provincial guidelines and standards in place in other jurisdictions.

In 1986, for example, the highest level in the city, measured near Portage Avenue, averaged 1.31 micrograms per cubic metre over a 24-hour period. The provincial guideline level for the same interval is 5.0 micrograms per cubic metre.

The introduction of unleaded fuels has been credited with reducing concentrations, here and in the rest of Canada. According to Environment Canada, the major source of lead in the atmosphere is from vehicles burning leaded fuels (85% in 1982).

Levels have not always been on the right side of the provincial guidelines. In the early to mid 70s, levels exceeded the guidelines several times, particularly around Winnipeg's secondary lead smelters. Monitoring near the smelters was discontinued after 1984 because air quality remained consistently good following enhanced maintenance and reduced operations at one of the smelters.

In 1984/85, a special survey at Weston School, which is near a smelter, showed that lead-in-air levels met provincial guidelines and similar to levels at other locations in the city. Measurements at ground level near Logan Avenue were higher than those measured at the school rooftop but still below guideline levels.

Lead can have an impact on the health of young children, especially when it is deposited on soils that can be ingested through the "hand-to-mouth" activities of children.

Arsenic at Lourdes

Tests of drinking water from the distribution system serving the village of Notre Dame de Lourdes in January 1990 revealed arsenic at levels as high as 0.062 milligrams per litre – well over the maximum acceptable concentrations of 0.05 milligrams per litre specified by the Canadian Drinking Water Quality Guidelines. The arsenic is thought to occur naturally in the soil.

At current levels in Notre Dame (population 627), the risk of skin cancer is between one in one thousand and one in ten thousand, according to Dr. T.D. Redekop, a medical officer with Manitoba Health. Dr. Redekop advised the village council that continued consumption of the water at the current high arsenic levels was unacceptable and that appropriate remedial action must be initiated to reduce exposure.

Arsenic is a documented human carcinogen. Although skin cancer is the principal cancer involved, scientific evidence suggests that bladder and other types of cancer may be caused by the same levels. Toxic effects other than cancer, such as chronic eczema and loss of hearing, have also been observed.

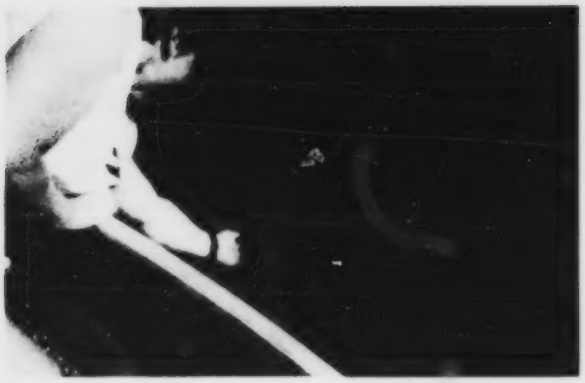
Staff from the Manitoba Water Services Board, with personnel from Manitoba Environment, are conducting pilot tests using manganese dioxide coated sand filters to reduce amounts of arsenic in the water. If they are successful, full scale tests will be undertaken at Notre Dame by the Manitoba Water Services Board.

Filtering technology is relatively inexpensive and, if found to work, could be applied at other Manitoba communities, as well as private well systems, with high arsenic levels. Meanwhile, monitoring continues in the village.

An earlier sampling of private wells in and around the village showed that shallow wells were relatively free of arsenic but deeper wells had high levels similar to those in the village supply. The shallower aquifer is capable of supplying water to the community with arsenic levels at 0.016 milligrams per litre.

The maximum acceptable concentration of arsenic in drinking water – currently under review – is expected to be revised downward from the present level of 0.05 milligrams per litre to 0.025 milligrams per litre. Several communities in Manitoba are known to have water supplies with arsenic levels of more than 0.025 milligrams per litre but lower than the current maximum acceptable concentration of 0.05 milligrams per litre.

The village of Notre Dame de Lourdes was established in southern Manitoba in 1890. It was named for Lourdes, a town in southern France visited by three million people each year, some of whom bathe in the sacred waters of a nearby grotto in hopes that a miracle will return them to health.



Algae Blooms Perennial Problem of Water Supplies on the Prairies

In the summer of 1989, algae blooms tainted Neepawa's drinking water which is drawn from Lake Irwin, an artificial reservoir built to supply the town. The blooms flourished in the warm, shallow waters of the reservoir which traps nutrients in runoff from surrounding farmland.

In the past, operators used copper sulphate to kill the algae but Manitoba Environment recommended against this measure because it could promote growth of a new strain of copper-resistant green algae. Although potassium permanganate was used in the water treatment plant, some odour persisted.

The problem recurred in the winter of 1989/90 when decomposing algae used up all the oxygen in the water and rotting organic matter fouled the water. Aeration was recommended to solve the problem.

Algae blooms on the Assiniboine River and in Lake Minnewasta often cause taste and odour problems in domestic water supplies in Brandon and Morden. In Brandon, city staff step up chemical feed rates at the water plant to control the problem. Operators at Morden treat Lake Minnewasta with copper sulphate to kill off the algae. Neither problem tends to last long, but many residents are angered by the inconvenience and turn to alternate sources of drinking water.

The problem often develops each summer in lakes and reservoirs across the province. Populations of blue-green algae are stimulated by a combination of high levels of nutrients, warm water, and long, sunny days. The water develops an unpleasant taste and odour and may even become unfit for human consumption.

Every summer algae blooms interfere with recreation on Lake of the Prairies. In 1990, they killed fish on Brereton Lake in the Whiteshell. Large algae blooms in Shoal Lake in late summer sometimes cause taste and odour problems in Winnipeg's drinking water.

Flin Flon Residents Blow Whistle on Fugitive Emissions

Hudson's Bay Mining and Smelting was ordered in 1989 to take action to reduce emissions and develop a public warning system when residents of Flin Flon raised concerns about potential effects of the fugitive emissions from the smelter.

Manitoba Environment installed an ambient air monitoring station in downtown Flin Flon in 1988 and the company installed four additional stations. If emissions reach high levels, public warning announcements are broadcast on local radio.

Although emissions of sulphur dioxide in Flin Flon generally fall within acceptable limits, in 1990 they still exceeded 1-hour-maximum acceptable levels for 249 hours on 85 days, spread fairly evenly over the year.

As long as concentrations of pollutants do not exceed maximum acceptable levels, soils, water, vegetation, animals, and people are considered to be adequately protected.

The company is committed under a regulation of The Environment Act to further reduce emissions to 220,000 tonnes as of January 1, 1994. The emissions totalled 266,000 tonnes in 1988 and 248,000 tonnes in 1989.

Manitoba's two northern smelters, at Flin Flon and Thompson, have been identified as minor contributors to eastern Canada's acid rain problems.

Chlorine Fumes Spark Panic

Each year Manitoba Environment's Emergency Response Team fields nearly 500 calls a year on its environmental accident hot-line. People phone in from all corners of the province to report on spills, leaks, and fires involving pesticides, fertilizers, fuel, and other chemicals.

A handful of calls prove to be false alarms, as in the case of a woman who rang at midnight in August of 1990 to report that acid fumes in their back yard were so strong it was impossible to open windows in the house. She wanted to know if she and her husband should evacuate. The cause: her husband had added too much chlorine to the swimming pool!

PCB Clean-Up On Alleghany Drive

Half a litre of transformer oil containing PCBs was cleaned up after it had leaked from a transformer on Alleghany Drive in Winnipeg.

Cleaning up the leak, which was reported by an anonymous caller in June 1989, involved removing soil for 60 centimetres around the transformer and to a depth of 60 centimetres below it, and replacing the transformer and the concrete pad under it.

Under a regulation of The Dangerous Goods Handling and Transportation Act, PCB wastes must be stored at specially designed and monitored sites and a detailed inventory of PCB wastes submitted to Manitoba Environment. The regulation does not apply to domestic quantities of PCBs.

Fluorescent light ballasts are being phased out because they contain PCBs. Because of their rugged construction, ballasts can be stored at minimum risk pending development of handling services. Manitoba Hydro has a program to test all of their equipment for PCB concentration. By June 1990, the corporation had cleaned more than 6 million litres of oil contaminated by PCBs.

Jury Still Out On 2,4-D

2,4-D is the most widely used herbicide in Canada, both agriculturally and domestically. Any ban or regulation of its use would have major economic repercussions, including the problem of disposing of the millions of kilograms already in circulation.

The herbicide has been under re-evaluation by Agriculture Canada and Health and Welfare Canada since 1981. A recent study involving farmers in Saskatchewan supports the interim position of Agriculture Canada, which calls for continued use with increased emphasis on proper protective clothing to prevent direct exposure.

2,4-D has been on the market in Canada since 1946 and is used to control weeds on an estimated 8 million hectares of farmland every year.

Meanwhile, Manitoba Environment continues to issue permits for the use of 2,4-D, on condition that applicators wear protective clothing, including goggles, respirators, rubber gloves, rubber boots, coveralls, and a water repellent hat.

Palliser Furniture to Clear the Air

Palliser Furniture has taken steps to remedy emissions from its particle-board manufacturing plant in Transcona, Winnipeg. The company was ordered by Manitoba Environment in December 1990 to control dust, smoke, odour, and other problems that have concerned residents in the neighbourhood.

To comply with the department's recommendations, the company hired a consulting firm to investigate the problems and recommend solutions. The consultants found that Palliser's two cyclones were causing most of the problems. The cyclones are designed to separate sawdust from the air before releasing the air outdoors, but fine wood dust was escaping from the cyclones and falling on surrounding properties. Exhaust from the cyclones was suspected of causing most of the odour problems. Wood fibre and coarse dust from operations on the grounds were also bothering residents.

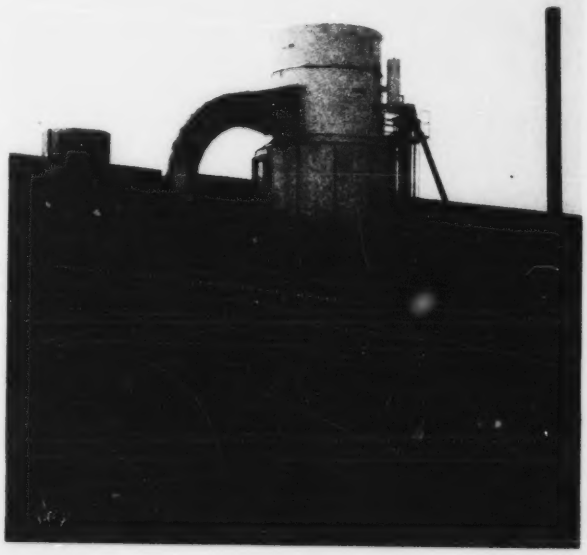
To address these problems, the consultants recommended that Palliser control exhausts from the cyclones and clean up its outdoor operations.

Palliser has agreed to build a "baghouse system" where emissions from the cyclones are routed through a shed to strip away dust and eliminate odours.

The company has put up a second building for storing and blending sawdust and woodchips, operations that were once handled outdoors.

Windbreaks are being erected to shield yard operations, and the company is scraping the top layer of ground from its property so that loose sawdust is not free to blow onto neighbourhood properties.

Manitoba Environment continues to monitor remedial operations to ensure that abatement measures are successful.



AGRICULTURE

Agriculture is the traditional mainstay of the province's economy. It is a major employer and producer, as well as a supplier of raw material to the food processing industries.

Investment in land, buildings, equipment, and livestock by Manitoba farmers averaged $9.2 billion from 1986 to 1989 – about $350,000 per farm. Agricultural sales for the same period averaged $2.0 billion, with $1.3 billion from crops and $0.7 billion from livestock.

Some of the problems of agriculture – wind and water erosion – can be reduced but not completely solved. And solving some of the problems causes other problems. Drainage to make land suitable for agriculture, for example, may dry out wetlands and deplete groundwater supplies by diverting flows from groundwater recharge areas. The challenge will be to find a middle ground that puts agricultural production on a sustainable basis without creating problems in other sectors of the economy and the environment.

A Regional Look at Agriculture

Agricultural production is concentrated mainly in the Grassland and Broadleaf/Mixedwood Forest regions. The Pasquia development at The Pas is the only major agricultural area in the Northern Coniferous Forest region. It has one community pasture.

Broadleaf/Mixedwood Forest

Fifty-six percent of this region is farmed even though only 25% of its soils are considered prime farmland. Most of the prime farmland is in crops, the lower classes in tame forage for livestock. The rest of the region comprises parks, forests, and vacant Crown land.

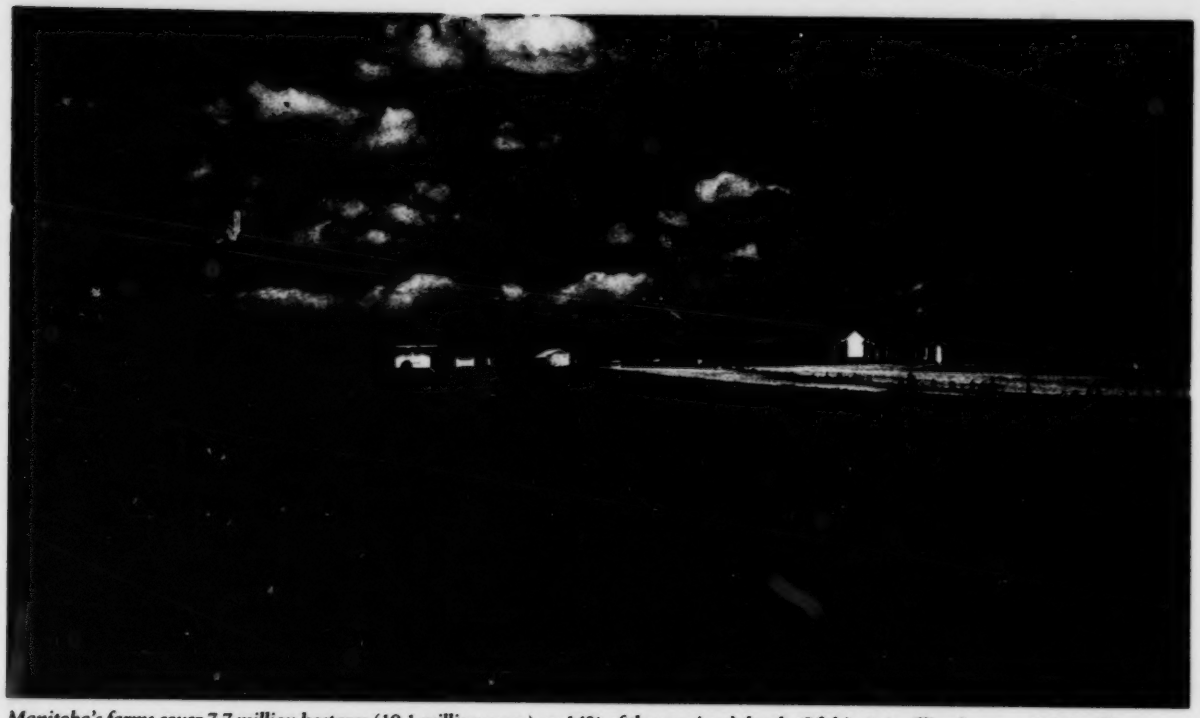
About 27% of the province's farmland and 24% of the farmers are in this region. Main crops are cereals, flax, and canola. One-third of Manitoba's beef cattle are raised here, mainly on ranches on the lower class lands of the Interlake and Westlake. Much of this grazing land is leased from the Crown. The Prairie Farm Rehabilitation Administration (PFRA) of Agriculture Canada in this region operates 14 of Manitoba's 24 community pastures. The 24 PFRA pastures cover 166,500 hectares (411,400 acres), with a stocking capacity of 36,200 head of mature cattle. About 85% of the pasture land is grazed in its native state, so that the stocking rate is low. But because native pastures and associated woodlots support a greater variety of plants and animals than managed, tame pastures, they contribute to our enjoyment of the countryside and help maintain biological diversity.

Grassland

Soils here are generally well suited to agriculture, with about 60% being prime farmland. Ninety percent of the region is farmed, with 88% in crops, including tame forage. About 85% of the province's cereals and oilseeds are produced here, plus nearly all of the special crops, which include potatoes, sunflowers, corn, peas, beans, lentils, buckwheat, mustard, canaryseed, sugar beets, and vegetables. The region has nine community pastures.

Farmers in the grasslands produce 90% of Canada's sunflower seed and nearly 50% of the flax and buckwheat.

The eastern third of the region supports the greatest concentration of livestock in the province, with 68% of Manitoba's poultry, 53% of the hogs, and 52% of the dairy cattle.



Manitoba's farms cover 7.7 million hectares (19.1 million acres), or 14% of the province's lands. Of this, 5.4 million hectares (13.3 million acres) are in crops and the other 2.3 million hectares (5.8 million acres) are used for grazing or for harvesting hay.

Agricultural Land Under Stress

When new developments, particularly urban subdivisions, are built on productive agricultural land, the land is taken out of production, often irreversibly.

Since most provincial land with good agricultural potential is already being farmed, there is little "new" land to make up for such losses.

Losses of agricultural land are addressed at several levels of the government. The Provincial Land Use Committee of Cabinet is currently setting general land use policies for the province. Decisions that affect Crown lands are always reviewed by a range of government departments to ensure that all concerns are addressed (see **Legislation**).

Under The Planning Act, administered by Manitoba Rural Development, rural municipalities and planning districts apply land use policies to deal with potential conflicts. For example, development is not allowed on prospective gravel pits, and different areas are zoned for residential or commercial expansion as well as for parks, playgrounds, or cottage developments. Other policies protect areas from uses that would deplete or pollute groundwater.

The Cooks Creek Conservation District, one of six conservation districts supported by the provincial government, deals with land fragmentation and land speculation in its Draft Management Plan for the District.

The District Board has agreed to continue encouraging provincial and municipal authorities to preserve productive agricultural land. It will support the strictest of land use controls to eliminate or at least limit losses in the District, and encourage municipalities to reject subdivision applications that would take prime agricultural land out of production.

Farming in the city's shadow (Cooks Creek Conservation District)

Making the Most of Our Soils

Of the 7.7 million hectares (19.1 million acres) farmed in Manitoba, only 25% are classified as Canada Land Inventory Classes 1, 2, and 3 – our best soils. The remaining 75% of our farmland is less productive and must be treated with care.

Nearly 2,000,0000 hectares (4,500,000 acres) or 40% of Manitoba's crop-growing lands are prone to wind or water erosion and require special farming measures to stay productive. Another 300,000 hectares (750,000 acres) of farmland are vulnerable to salinity.

Land prone to flooding cannot be farmed if drainage systems do not operate properly. But drainage systems may speed surface runoff, divert water from wetlands, and prevent the proper recharge of groundwater aquifers (*see* **Water** and **Wildlife**).

These problems are addressed by soil policies formulated with the help of public consultation as part of an overall land and water strategy for Manitoba. The policies promote programs that reduce erosion, enhance soil moisture, promote appropriate land use, and improve soil management (*see* **Sustainable Development**).

One of the policies, on wetlands and groundwater , specifies that "maintenance of existing drainage systems will be preferred over expanding the systems into areas that may be only marginally suitable for agriculture."

Farmers apply a range of conservation techniques to make the most of their soils: crop residue management, crop rotation, stripcropping, shelterbelts, forage seeding, and installing grassed waterways (low-cost, easy-to-maintain natural runways to prevent gullying in erosion-prone areas).

Shelterbelts

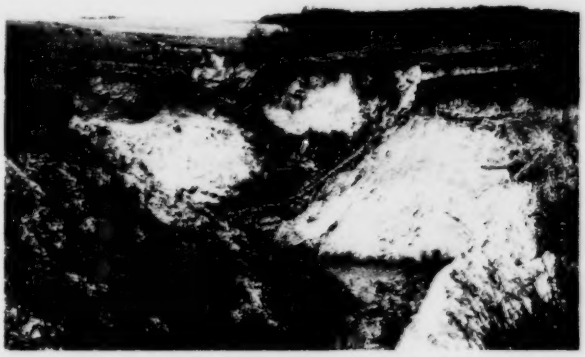
Since the 1930s, the province of Manitoba has funded farm shelterbelt planting programs to help combat erosion. More than 1,300 kilometres of shelterbelts have been planted each year for the last several years under a cooperative program involving farmers, municipalities, conservation districts and associations, Manitoba Agriculture, and the PFRA. Some 1,600 kilometres of shelterbelts were planted in 1990.

Less Stubble Burning

Burning straw from a wheat crop can destroy up to $8 per hectare ($3 per acre) of nitrogen, leaving the field impoverished, more costly to fertilize and more attractive to weeds. Burning limits soil moisture by removing straw and stubble that capture snow. Straw and stubble shelter land from strong winds and heavy rains by binding soil particles together. Leaving crop residues after the harvest helps boost soil organic matter, making the soil easier to work for less time in the field, lower fuel consumption, and less wear and tear on equipment. (Flax straw remains a problem because it does not break down fast enough.)

Manitoba farmers have gradually reduced the amount of stubble they burn. A survey in the Winnipeg region showed that farmers burned 5% less cereal stubble in 1989 and 1990 than in 1987, and much less than a decade earlier.

Forty percent of Manitoba's croplands are vulnerable to wind erosion.



More than a quarter of our farmland is vulnerable to water erosion.

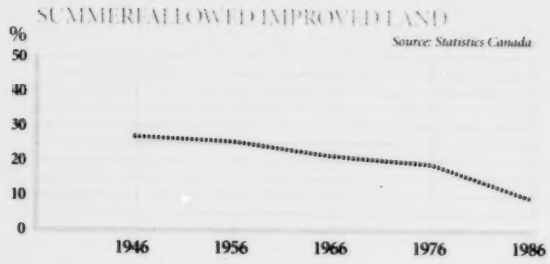
Some 300,000 hectares (750,000 acres) of land are affected by salinity.

Less Summerfallow

Summerfallow, the practice of cultivating land without planting it, has been the traditional approach to controlling weeds, storing soil moisture, and boosting nitrogen levels in the soil.

But research has shown that the practice does not work well in storing soil moisture for Manitoba crops. It contributes to soil erosion and salinity, and leads to losses of soil organic matter, the lifeblood of agriculture. Manitoba farmers have turned instead to longer crop rotations to increase farm productivity. They have cut summerfallow acreage from about 25% of cultivated land in the 1940s and 1950s to only 9% in 1986.

In areas with saline soils, farmers plant salt-resistant crops and plow in straw and manure to boost levels of organic matter.



Irrigation

Irrigation helps increase yields and minimize weather-related uncertainties for a variety of Manitoba crops. It is one of the keys to producing vegetables and other high value crops, and benefits the food-processing industries which provide employment for Manitobans.

Only 12,000 hectares (30,000 acres), or 0.25%, of Manitoba's cultivated land is irrigated. There are markets for more irrigated crops, additional water supplies are available in some areas, and Manitoba has a large area of irrigable soils, presenting opportunities to produce more food and create jobs. But limited water supplies will probably restrict further irrigation development to two or three times the amount of land now irrigated.

If applied carelessly, water used in irrigation can wash chemicals and toxic elements from the soil, increasing their concentration in runoff. It can also endanger groundwater supplies, particularly in locations with specialty crops where growers depend heavily on chemical fertilizers and pesticides.

To date, all irrigation in Manitoba has been private. In response to proposals for irrigation projects from farmer's groups, the province will be embarking on a study of irrigation involving the public as well as several provincial departments. Concerns will include protecting water quality, locating and managing projects to prevent long-term soil degradation, and maximizing benefits to recreation and wildlife. The challenge will be to plan and direct development in keeping with the principles of sustainable development.

In Manitoba, the use of groundwater for irrigation is licensed and monitored by Water Resources. Licences are also required for pumping irrigation water from lakes and rivers.

The temporary flooding of land with spring runoff is one form of irrigation that may prove effective for farmers in some parts of the province. The technique takes advantage of Manitoba's spring floods, when rapid snow melt and spring rains combine in streamflows that far exceed the capacity of our stream channels. In locations where soils are saline, soft floodwaters help flush salt from the soil.

Farming for Tomorrow

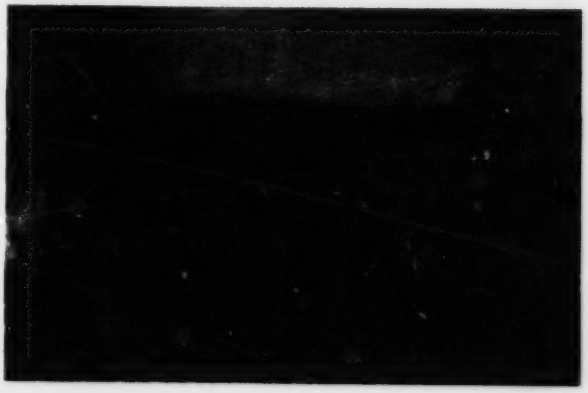
Programs to put many of the province's soil policies into action will be funded by the Farming for Tomorrow program under the terms of a federal/provincial Agreement on Soil Conservation signed in 1989. This involves the formation of 43 soil and water associations, involving members of local communities, to make decisions on initiatives involving conservation for their areas.

Financial incentives will be delivered through local organizations to support conservation practices.

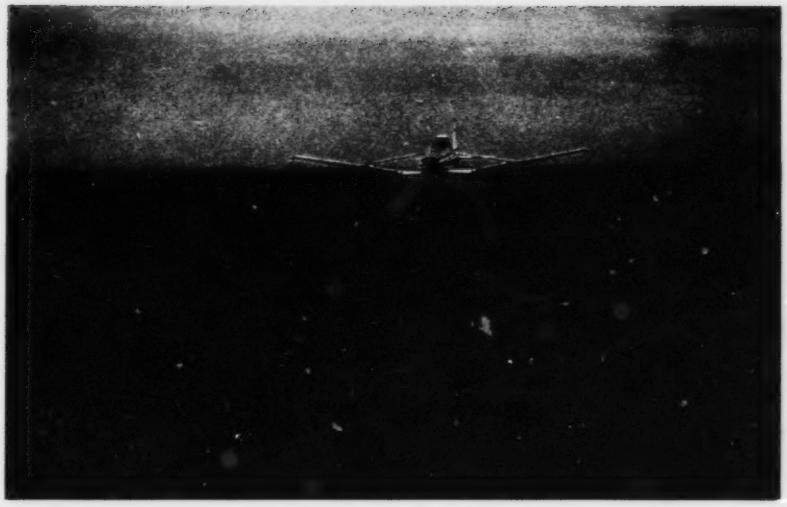
Farming for Tomorrow will fund a variety of activities to help curb erosion and keep the soil productive – conservation tillage, field shelterbelts, grassed waterways, gully stabilization, runoff control structures, salinity management, and soil improvement crops.

It will help cover the costs of seeding fragile lands to forage crops and encourage public purchase of fragile land for conservation. Conservation education, aimed at school children and the general public, will round out the program.

Fields burned annually suffer long-term yield reductions of up to 25% compared to neighbouring fields that are not burned. By abandoning the practice of straw burning, Manitoba farmers are sustaining land for tomorrow while maximizing productivity today.



The Productivity Dilemma



Better crop varieties and machinery and improved weed and pest control measures have dramatically increased the productivity of our farmlands. Average wheat yields have increased 74%, from less than 1,300 kilograms per hectare (19 bushels per acre) in the 1940s to more than 2,200 kilograms per hectare (33 bushels per acre) in the 1980s.

In the early years of farming in the province, organic matter that had been built up over centuries was drawn on by cropping and summerfallowing. Farmers did not use fertilizer other than applying small amounts of manure to the fields. Today, nitrogen and phosphorus from fertilizers are replacing some soil nutrients, helping it to sustain its productivity. Unfortunately, chemicals alone do not build up soil organic matter. For that, livestock manure, where available, is returned to the land. Crop rotation, green manure crops, and elimination of summerfallow also help.

Farmers now use 35 times as much fertilizer as they did in the 1950s, with annual use at an all-time high of 650,000 tonnes. Cereal and oilseed crops seeded on stubble land receive about 60 to 70 kilograms per hectare (50 to 60 pounds per acre) of nitrogen annually, and special crops even more.

From 1986 to 1988, herbicide use in the province averaged 4.4 million kilograms – less then 1 kilogram of active herbicide per hectare of cropland (1 pound per acre). Quantities of insecticides, fungicides, and other chemicals being used to control pests are not well known because farmers do not need a licence to apply them and use them only in years when they have to deal with an outbreak of pests.

On the one hand, continued use of fertilizers and pesticides may be necessary just to keep the land productive. On the other, care must be taken to use these products carefully to keep them out of our streams, lakes, and groundwater (*see* **Water**).

Natural Herbicides Studied

Researchers in government departments and universities are currently at work on biological weed control measures and pest management methods to reduce pesticide use.

They are monitoring several types of insects with potential to help control perennial noxious weeds – leafy spurge, bladder campion, Canada thistle, and sow thistle. Seed-feeding and crown-boring weevils have been released on nodding thistle, and a plant pathogen has been evaluated for controlling round-leaved mallow.

The responsible use of fertilizers is an integral part of soil research and soil testing programs in Manitoba. Under a service offered by Manitoba Agriculture, farmers are encouraged to analyse their soils before seeding, to determine quantities and types of fertilizers needed in light of nutrients already in the soil, crops to be sown, and climatic conditions.

Fertilizers are often applied in a band in the soil near the seed, to improve the efficiency of fertilizer use. This results in less fertilizer being applied for the same yield, and less chance of wastage.

Pesticides

Under The Pesticides and Fertilizers Control Act, pesticide dealers and applicators must successfully complete specialized training offered by Manitoba Agriculture and Manitoba Environment before they can obtain a licence to handle pesticides in Manitoba.

Training covers identifying pests, selecting pesticides, calculating product amounts, and calibrating equipment for safe, responsible application and use. The program is complemented by a pesticide container cleanup project that involves rural municipalities (*see* **Focus Issue – Waste Management**).

Weeds

The Noxious Weeds Act and the Weed Control Districts program help prevent the introduction and spread of noxious weeds in Manitoba.

Many municipalities jointly hire weed "supervisors" to take charge of weed control programs. The supervisors and other weed control staff must be licensed and trained in identifying species, handling chemicals, and calculating and applying correct dosages.

Minimum Tillage Growing in Popularity

The last 2 decades have seen intense interest on the part of many Manitoba farmers in minimum and zero tillage. These practices reduce or eliminate cultivation of the soil, cut tillage costs, and reduce wind and water erosion and soil moisture evaporation.

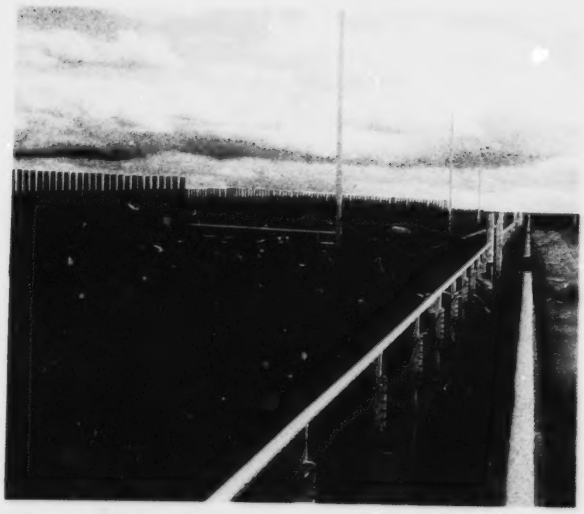
For several years, farmers in the province have practised zero tillage on 8,000 hectares (20,000 acres), but some have

found it difficult to control some of the perennial weeds without heavy applications of herbicides or cultivating every few years.

Most Manitoba farmers already use minimum or reduced tillage practices on a significant part of their land.

Better Milk Production

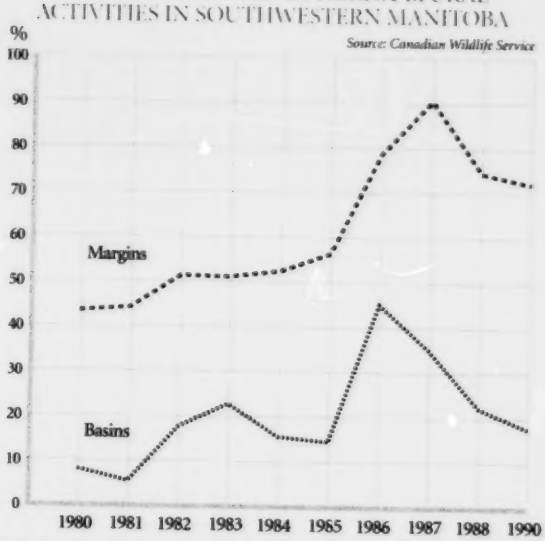
The number of dairy cows in the province has gradually decreased over the last 40 years, from 277,000 in 1946 to the present 65,000 cows. Yet average milk production per dairy cow has roughly doubled through improved breeding, feeding, and management!



When runoff from cattle feedlots and large-scale pig-feeding operations escapes directly to surface waters, it can cause nutrient loading, loss of oxygen, eutrophication, and similar environmental problems that threaten water quality. A regulation under The Environment Act addresses the quality of runoff from livestock operations, with the aim of protecting receiving waters. In its present form, however, the regulation does not cover certain types of farms that can cause pollution. Examples are the feeding or watering of livestock in concentrated areas at or near streams or lakes.

WETLANDS AFFECTED BY AGRICULTURAL ACTIVITIES IN SOUTHWESTERN MANITOBA

Source: Canadian Wildlife Service



Agricultural use of the land, while an acknowledged necessity, nevertheless has a considerable impact on other uses. In 1989, according to surveys carried out by the Canadian Wildlife Service, 23% of wetland basins and 78% of wetland margins were affected by cultivation, burning, grazing by livestock, or a combination of these uses in southwestern Manitoba.

Trends

Supply of prime farmland ——— **Worse**
Productive land continues to be lost to non-agricultural uses, putting more pressure on remaining arable land.

Conservation farming ——— **Better**
Minimum and reduced tillage are growing in popularity, and farmers are summerfallowing less. Shelterbelt planting continues, with modest increases planned, reducing wind erosion and boosting soil moisture by encouraging greater retention of snow cover. Crop rotation and other sound farming practices are common, and stubble burning has decreased.

Alternate pest control ——— **Better**
Recent years have seen an increase in the use of biological methods of pest control.

Impact on wetlands ——— **Same**
Cultivation, burning, and livestock grazing continue to disturb wetland habitat for nesting waterfowl and other wildlife.

ENERGY

Energy fuels Manitoba's economy and literally keeps us alive. It moves goods and people, lights and heats homes, businesses, and institutions, and powers heavy industry, manufacturing, and agriculture – to name but a few uses.

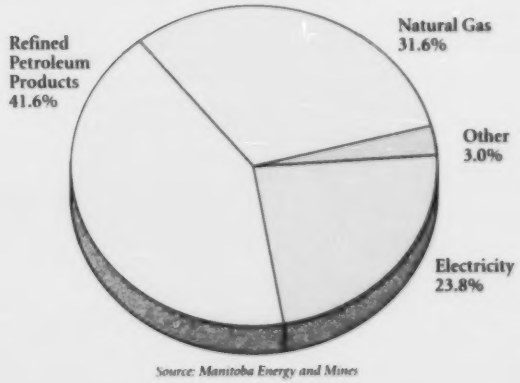
We consume more energy than we produce: about 75% of our gross energy requirements are imported. As a result, most of the $2 billion we spend annually on energy leaves the province.

Electricity, generated mainly from water power, is our major indigenous source of energy. We also produce crude oil, all of which is exported.

Refined petroleum products supply 42% of Manitoba's energy consumption, followed by natural gas at 32%, electricity at 24%, and coal at 2%.

This section focuses mainly on hydroelectric energy which is the major form of energy we produce. The impacts of oil, natural gas, and coal are also covered elsewhere in the report (see ***Air*** *and* ***Transportation****).*

MANITOBA ENERGY CONSUMPTION – 1989
by fuel type (224,733 Terajoules)



Source: Manitoba Energy and Mines

Electricity

In 1989, Manitoba had an installed generating capability of 4,048 megawatts, 90% of which can be produced by hydroelectric stations, mainly in northern parts of the province. The remaining 10% can be produced by coal-fired thermal stations and isolated diesel oil generators. Our undeveloped hydraulic potential is about 9,000 megawatts.

Most of Manitoba is connected to the main power grid, with the exception of isolated communities in the north that rely on, localized generation. In 1989, Manitoba produced 18,741 gigawatt hours of electricity, an effort that directly employed 5,000 people. Electricity supplied to end users in the province was valued at $643 million, and exports brought in $53 million. Provincial government revenues from renting water used for electrical generation were $29 million.

The less water there is, the less electricity is produced. During years of low precipitation, hydroelectric generation is supplemented by exchanges with other utilities and by coal-fired thermal generating stations in Brandon and Selkirk.

Manitoba has no nuclear power plants. Economics favour hydraulic development over nuclear.

Oil, Natural Gas, and Coal

Oil and natural gas exploration began in the province in 1877. In 1951, the first commercial oil-producing well was discovered near Virden in the Daly oil field. By 1953, more oil fields were discovered in southwestern Manitoba, including the Virden field. By 1960, most of the Virden and Daly fields had been fully developed, and oil production was on the decline.

During the early 1980s oil exploration increased in response to rising international oil prices. The Waskada field was developed extensively. With the collapse of oil prices in 1986, only 135 wells were drilled, half the number drilled in 1985. Activity in Manitoba's oil patch continues to track changes in crude oil prices.

In 1989, Manitoba produced about 1% of Canada's crude oil – some 722,820 cubic metres valued at $90.1 million, from 1,353 producing oil wells in the southwest

corner of the province. The oil industry directly employs about 250 people and yields revenues of $9.43 million for the provincial government.

All of Manitoba's crude oil production is exported, mostly to the United States and Ontario. Since we have no oil refineries, we import all refined petroleum products.

Manitoba produces no commercial natural gas, but imports all of its requirements, primarily from Alberta. Small amounts of natural gas produced in association with oil are generally flared or used as field processing fuel. In the Waskada Field, processing of raw gas yielded about 8,000 cubic metres per day of propane, butane, and other natural gas liquids in 1989. The remaining dry gas is injected into an underground reservoir for storage and to facilitate oil recovery.

In 1989, nearly 1.9 billion cubic metres of natural gas were consumed, costing $258 million, and 154 megalitres of natural gas liquids were consumed, at a cost of $42 million. In the same year, the refined petroleum products industries employed 4,800 people, and the natural gas industries, 800 people.

There is no coal production in Manitoba although coal was once mined in the Turtle Mountain area. In 1989, 130,600 tonnes of coal were burned, at a cost of $3.6 million, mainly for thermal electricity generation in Winnipeg, Brandon, and Selkirk.

Thermal electric generating plants discharge cooling water into rivers and emit sulpher dioxide, nitrogen dioxide, and particulates into the air (*see* **Water** and **Air**).

Source: Manitoba Energy and Mines

Impacts of Hydroelectric Development

Hydroelectricity is considered a relatively benign source of power compared to other forms, but the equipment and facilities used to generate, transmit, and distribute electricity can have a range of impacts on the environment, from flooding to electromagnetic effects. Many of the most serious impacts were felt in the last 30 years when the Churchill River Diversion, Lake Winnipeg Regulation, Grand Rapids, and other major projects were built.

Flooding

More than 2,600 square kilometres of land, mainly in northern parts of the province, has been flooded for hydroelectric production – about the size of the south basin of Lake Manitoba. Along with the loss of land, flooding disrupts the economy and lifestyles of northern residents. High water levels flood and hamper access to traplines and destroy essential habitat for furbearers, ungulates, and waterfowl. In areas where water levels have dropped, travel to good hunting areas may be blocked.

Flooding can destroy shoreline vegetation, erode shorelines, undercut banks, and build sandbars and deltas downstream. Water restrained by dams or shunted into diversions drowns soils and vegetation that release nutrients, and leaches mercury from soils, changing water chemistry. Siltation increases, coating spawning sites and disrupting migration patterns.

Oxygen depletion caused by decaying vegetation hurts fish and the food that fish eat. A decline in the growth rates of prey species such as whitefish and walleye prolongs their susceptibility to predators such as pike.

Marshes are destroyed by alternate flooding and drawdown. Submergent vegetation, food for waterfowl, does poorly when turbidity increases. Islands used by waterfowl for nesting shrink or disappear with higher water levels. Shoreline vegetation used by moose, furbearers, and waterfowl for food and cover is submerged by floodwaters. Winter drawdowns freeze out furbearers and form hanging ice that makes it difficult for moose and caribou to cross lakes.

Flooding also produces methane, a greenhouse gas, and when it kills forests, it eliminates the carbon dioxide absorption action of trees.

When flooding leaves debris in waterways, it presents a hazard to commercial fishing and tangles nets. Hydro has programs for debris clearing that are carried out in conjunction with local communities. Along the Churchill River Diversion, where flooding left debris in the waterway, Manitoba Hydro compensated residents for extra effort to harvest fish.

The aesthetic appeal and recreational potential of dam sites are enhanced by cleaning up, grassing, and installing visitor facilities. Cleanup measures can include clearing and disposing of trees and shrubs growing below full supply level in forebay areas, and cleaning floating debris from reservoirs. At Southern Indian Lake, Manitoba Hydro cleaned landing sites for fishermen at regular intervals along the new shoreline. At Cross Lake, because hydro development changed the natural pattern of seasonal water levels, Hydro is proposing to build a weir to help raise the water to near natural levels. The corporation is also flying Cross Lake hunters into traditional hunting areas.

The proposed Conawapa Dam would flood less than 4 square kilometres because nearly all of the flood waters would be contained within the natural banks of the Nelson River.

Lifestyles and Culture of Native People

Most Manitobans never see or feel the effects of northern generating stations on the environment. Flooded areas are often in the "backyards" of Native people, remote from our southern population centres.

The traditional lifestyles and pursuits of native people have suffered major impacts in the wake of hydroelectric development (*see* **Water**). In commenting on the effects of the hydro project at Grand Rapids, the Summerberry River Fishermen Group had this to say: "For Indian people in northern Manitoba, the lakes and waterways are like our veins, they are our lifeblood. In 1962, it was difficult to imagine that the lands and waters, which we had known for generations, could suddenly change; that the spawning grounds, the best fishing places, and even the quality of the fish itself could suddenly be turned around by man." Manitoba Hydro recently signed agreements to settle some outstanding obligations relating to the Grand Rapids hydroelectric development in the amount of $20 milllion.

Hydroelectric development can also have a range of positive socioeconomic impacts, from job creation and skills transfer during construction to availability of electrical power.

Access

New roads can increase harvesting pressures on forests, wildlife, and fish. A concern of the permanent road to the Conawapa Dam site is that it would open up previously remote areas such as the Cape Churchill Wildlife Management Area, the Hudson Bay coast, and the York Factory site. Manitoba Hydro closes its access roads to all traffic other than its own. If the roads are later designated as provincial roads or trunk highways, they come under a wildlife regulation that prohibits hunting or discharging of firearms.

Stream Crossings

Poorly constructed stream crossings can cause erosion, impede fish, and restrict flows. Several kilometres of brook trout habitat were destroyed by siltation caused by stream crossings along access roads to hydroelectric stations on the lower Nelson River. Under the stream crossing guidelines prepared by Natural Resources, access roads must be built in ways that accommodate fish passage, protect aquatic habitat, and limit erosion.

Transmission Lines

There are about 77,500 kilometres of electric transmission and distribution lines in Manitoba, with right-of-ways and easements covering more than 18,000 hectares. High voltage transmission corridors also affect the environment. There is some disruption of land use and associated ecosystems with right-of-way clearing and herbiciding.

Manitoba Hydro must submit applications to Manitoba Environment describing treatments proposed to control tree growth along transmission lines. The corporation must also advertise its intentions in local newspapers to give the public a chance to register objections.

Electric and Magnetic Fields

Although evidence to date is inconclusive, there is growing concern about the risks to human health of the electric and magnetic fields produced by power lines, electric blankets, waterbeds, microwave ovens, or any other device that transmits electricity. Recent studies suggest a possible link between certain forms of cancer in people and increased exposure to electric and magnetic fields. Most worldwide scientific evidence, however, supports the position that a public health risk from exposure to these fields has not been established. Further studies in the next decade are expected to determine if these fields pose a health risk to the public or present an environmental concern. Hydro monitors, participates in, and supports research programs in these fields.

In 1976, the Churchill River Diversion in northern Manitoba diverted 75% of the flow of the Churchill River into the Rat, Burntwood, and Nelson rivers. This 15-year project flooded more than 76 ,000 hectares, and triggered raised mercury levels in fish above those specified in the Canadian guidelines as safe for human consumption. Flooding by reservoirs mobilizes mercury naturally present in soils. The mercury is converted by bacteria to a form that is soluble in water and easily absorbed by fish and other aquatic life. Mercury levels in people living in the two communities along the diversion route generally tested within the normal range. But there was concern for above-normal levels in women of child-bearing age because of the sensitivity of the fetus to mercury poisoning. Mercury levels, although elevated, were below toxic levels in mink and otter. It may take decades for mercury levels in predatory fish to return to pre-impoundment levels. Mercury concentrations in whitefish from Southern Indian Lake have declined from their post-impoundment peak.

Energy Options

According to long-term projections, the cost of most forms of energy is expected to rise, along with demand. Total energy demand in 2005 is expected to increase by up to 30% over the demand in 1987.

A growing demand for energy means more spending on imported nonrenewable resources (petroleum products and natural gas) as well as more spending on developing indigenous energy sources (mainly electric generation facilities). Rising energy costs, coupled with rising demand, mean an even greater burden on Manitoba's economy and stress on the environment, since energy production and use, especially of fossil fuels, adds to air pollution and the greenhouse effect (*see* **Air**).

Greater end use efficiency reduces fossil fuel emissions and the need to build as many electrical generating stations. The development of solar, wind, and other alternative renewable energy sources can also make a contribution to Manitoba's energy needs. The substitution of these and other forms of renewable energy for fossil fuels is constrained by economic and technological factors. Alternatives to petroleum product use in the transportation sector are limited. Electric and hydrogen automobiles still have technological and cost disadvantages compared to gasoline-powered cars.

Because of projections that the province will need additional electrical energy sources by about 2000, Manitoba Hydro has adopted a four-point plan:

- sale of 1,000 megawatts to Ontario Hydro for 22 years starting in the year 2000
- exchanging power with utilities in the United States to meet their needs in summer and our needs in winter
- a 100-megawatt reduction in load forecast by 2001 by encouraging residents, business, and industry to use electricity wisely
- rehabilitation work on Hydro's thermal generating stations in Brandon and Selkirk.

Manitoba Hydro is also looking into the possibility of customers generating their own electricity by recapturing waste energy. It is scrutinizing its own operations which consume 15% of the total amount of power it generates.

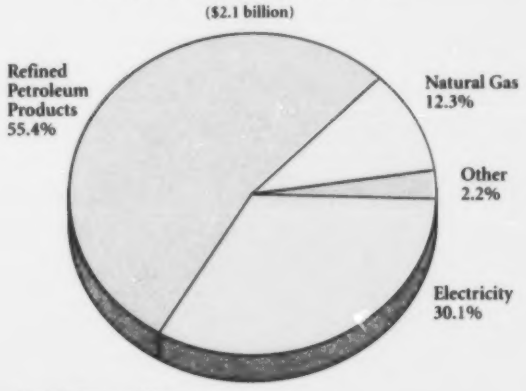
The sale agreement with Ontario Hydro, which was signed in 1989, set in motion plans to build the Conawapa generating station and its associated transmission facility, Bipole III, a transmission line more than 800 kilometres long linking the converter station at Henday with the power grid to the south.

The proposed construction of Bipole III will involve clearing a 76-metre-wide right-of-way through wooded areas on either the east or west side of Lake Winnipeg. In keeping with provincial regulations, buffer strips of low-growing trees and shrubs will be left at major stream crossings and other environmentally sensitive sites to minimize soil erosion and spare fish and wildlife habitat. Crews will use hand or mechanical cutting procedures or herbicides for vegetation control, depending on site sensitivity. Herbicides will not be applied near streams, lakes, and other sensitive locations.

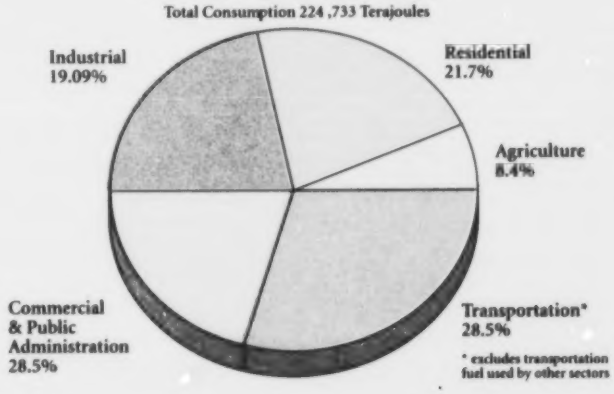
To avoid discharging cooling water to streams, converter stations will use closed system heat exchangers and refrigeration units. PCBs will not be used in any equipment on site.

In its planning for Bipole III, Manitoba Hydro will be addressing other concerns, including the socioeconomic impacts of line construction and maintenance on local economics, environmental impacts on natural resources and wilderness parks or reserves, impacts on agricultural practices and farm properties, visual or perceived nuisance effects on the enjoyment and marketing of the wilderness experience, impacts on the value of cottage properties and wilderness lodges, and the electrical and biological effects of high voltage transmission lines.

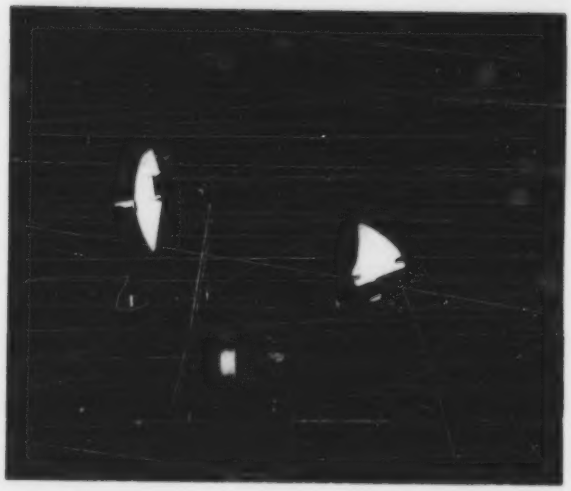
RETAIL VALUE OF MANITOBA ENERGY CONSUMPTION - 1989



MANITOBA ENERGY DEMAND BY END USER SECTOR - 1989



Source: Manitoba Energy and Mines



Oil and Salt Water Spills

Spills of oil and salt water are the chief environmental concerns associated with oil production and transportation. In 1989, there were 69 accidental spills of these materials, mainly from flowlines and at well-heads. Spills averaged 5.8 cubic metres with the total volume of oil and salt water spilled measuring 402 cubic metres or 0.006% of the volume produced and transported. As of the end of 1989, roughly 20 hectares at some 300 sites were under active rehabilitation because of spills.

In 1989, Manitoba had 710 kilometres of large-diameter oil pipelines along rights-of-way covering 1,200 hectares. We have 1,221 kilometres of flowlines, small-diameter pipes that connect wells and major pipelines. Oil is also transported by truck.

In Manitoba water produced in association with oil is extremely salty. It can damage the soil and is not suitable for watering plants and animals. Until 1980, before regulations banned the practice, salt water was stored in earthen pits where it could contaminate surface water and groundwater and kill vegetation. Producers are now required to store it in tanks before injecting it back into their oil reservoirs where it helps to maintain pressure. Some salt water pits that were emptied and filled with clean soil are still marked by bare patches of ground.

The oil and salt water from an oil well is carried by flowline from the well head to a treater where the oil and water are separated. The system includes an oil storage tank, a salt water tank, an injection pump, and a flowline to the salt water disposal well. Each segment is constantly checked and repaired, but because the fluids involved are extremely corrosive, the system eventually deteriorates. If standard operating pressures are exceeded, or the equipment malfunctions, the system can fail, releasing oil or salt water.

New operations are another source of accidental spills. Because of the fast pace of development, temporary tanks are used to store fluids that are then transported by truck to central processing facilities, increasing the possibility of a spill.

Metal pipes and connectors are being replaced with fibreglass or PCV pipes and connectors. Operators are replacing old lines and using corrosion resistant materials, corrosion inhibiting chemicals, and cathodic protection. Special features are required on oil producing facilities to minimize the volume of any potential spill. If a spill occurs, a detailed report must be filed with Manitoba Energy and Mines describing why the spill occurred and preventive measures. Spills over 50 litres are reported to Manitoba Environment. The spill site must be cleaned up and any damaged areas must be rehabilitated. The number and size of spills have decreased in recent years, in part because of an aggressive campaign to identify and eliminate risky situations.

Drilling muds, water-based slurries of clay and additives used to maintain drilling pressure and bring drill cuttings to the surface, are considered a minor environmental concern. They are stored in pits and samples are sent to the Petroleum Branch for testing. If the pH of the mud falls outside a range of 5 to 10, the mud is treated with acids or bases until it meets the range. If salt concentrations are above 2,000 ppm, the muds are more toxic and must be disposed of accordingly. If the muds meet the requirements, they are spread on the ground and the storage pits are filled and levelled. Until 1984 when the Petroleum Drilling and Production Regulation was introduced, testing of drilling muds was not mandatory.

Natural Gas

There is no commercial natural gas production in Manitoba. In 1986, about 3,000 kilometres of natural gas pipelines were located outside urban areas along rights-of-way covering 2,180 hectares. Some 315 kilometres of pipelines transport gas liquids. The major environmental danger of any pipeline break would be an explosion.

Explosions although rare can occur when the pipeline has been accidentally damaged from digging. The gas utility company, the fire department, and Manitoba Labour respond.

TransCanada PipeLines Limited (TransCanada) designs, constructs, and operates its facilities to alleviate negative impacts on the environment. Its efforts focus on protecting heritage resources, constructing proper stream crossings, rehabilitating right-of-ways, and maintaining water quality and quantity. TransCanada keeps municipalities, provincial government agencies, and local interest groups posted with information packages containing location maps, the company's *Environmental Practices Handbook*, a landowner's guide on the implications of the proposed projects, and instructions on how to take part in the National Energy Board approvals process. The company prepares year-after monitoring reports on areas where they have installed pipelines.

Legislation and Regulation

Hydroelectricity

Under The Manitoba Hydro Act, the corporation can acquire land and rights-of-way, and must pay compensation. It also conducts environmental impact assessments of proposed hydroelectric projects. Assessments must cover the exploration, construction, and operational phases of proposed projects and ancillary facilities.

Public participation and community consultation programs are a major part of Manitoba Hydro's project approvals process. They are designed to facilitate review of the corporation's projects and of its treatment of related public concerns. In 1990, the Public Utilities Board reviewed Hydro's four-point development plan that would result in the full development of the Conawapa and Bipole III projects by 2000. New facilities must meet the terms of the provincial planning process and the Manitoba Environment Act. Reviews by a provincially-appointed Technical Advisory Committee and formal hearings by the Clean Environment Commission are included in the process.

Oil

Exploration and production of crude oil is regulated under The Mines Act and by the Oil and Natural Gas Conservation Board. Transportation is regulated under The Pipe Line Act. The Mines Act promotes recovery of petroleum resources for the benefit of all Manitobans, with minimum disruption of the surrounding environment and other resources. The Surface Rights Act covers procedures and compensation for acquiring surface rights. It contains provisions for restoring the surface afterwards, and resolving disputes between operators, landowners, and occupants. The Environment Act deals with the control of hazardous materials and response to environmental accidents.

Wildlife and Parks branches review requests for petroleum leases in wildlife management areas and parks, and restrictions on surface access may be imposed.

Specific regulations and policies prohibit operators from intentionally spilling oil and salt water. Accidental spills must be reported promptly, and the operator's plans for control, clean-up, and site reclamation must be approved by Manitoba Energy and Mines. Manitoba Environment and Energy and Mines team up for fast response to spills.

Spills caused by the petroleum industry can contaminate drinking water and damage surface soils. For these reasons, Manitoba Environment and Manitoba Energy and Mines work together in dealing with spills. In 1982, the departments set up a formal reporting strategy for fast response.

Natural Gas

The Gas Pipe Line Act covers terms and conditions for the construction and operation of gas pipelines to ensure public safety and the public's interest. Regulations are made pursuant to the Act. The Gas Storage and Allocation Act regulates supply.

Restoring disturbed areas is a challenge in the difficult climate and soils of the north. After 4 years of test plot studies using grasses in different site conditions, Manitoba Hydro seeded and fertilized 20 hectares of cleared land around the generating stations at Long Spruce and Limestone.

Energy Conservation Programs

The province is taking a fresh look at our overall use and generation of energy, in keeping with the principles of sustainable development. The suggested policies were opened to public consultation through the *Workbook on Energy Strategy*, released in November 1990. Other energy conservation initiatives are outlined below.

Manitoba Energy and Mines

Energy and Mines offers several programs to promote energy efficiency and conservation. Reducing energy consumption in turn reduces greenhouse gases and other atmospheric emissions, and delays or downsizes new electrical generation requirements. A free energy audit for home owners gives impartial advice on how to save energy. Home energy savers workshops are held throughout the year to educate the public. Retailer training seminars are held to educate staff of building supply stores on energy efficiency. The department also publishes booklets on energy saving techniques; offers free energy audits and energy management information for the industrial, commercial, institutional, and agricultural sectors; and finances studies and demonstration programs in renewable and alternate energy.

Manitoba Hydro

Manitoba Hydro advises consumers on energy conservation and efficiency in the residential, commercial, agricultural, and industrial sectors. Hydro offers rebates to those who purchase plug-in timers for the block heaters on their cars, and recommends installing ceiling fans, tuning up furnaces, insulating attics and basements, and caulking and weather stripping doors and windows to conserve energy at home and at the office. The use of energy efficient motors and microwave technology can improve electrical efficiency for commercial and industrial customers.

Trends

Energy demand ——— **Worse**

Manitoba, a net importer of energy, is expected to need more energy in future, probably at higher prices, which will put a greater burden on our environment and economy.

Environmental reviews of energy projects ——— **Better**

Construction of generating stations, transmission lines, natural gas pipelines, and other major energy works must meet the terms of the provincial planning process and is subject to exhaustive environmental reviews and licensing under both provincial and federal legislation.

Public consultation ——— **Better**

Manitoba Hydro holds public consultation meetings with agencies, groups, and interested individuals to discuss local issues affecting its proposed transmission line routes, station locations, and other projects. TransCanada PipeLines notifies the public of its proposed projects and sends out information packages to concerned groups and individuals.

Energy conservation ——— **Better**

Manitoba Energy and Mines and Manitoba Hydro provide the public with information and advice on energy efficiency and conservation.

Alternate energy sources ——— **Same**

Substitution of alternatives to fossil fuels is hindered by economic and technological factors.

Handling of oil and salt water spills ——— **Better**

In 1982, Manitoba Environment and Energy and Mines set up a formal reporting strategy for fast response to spills. In the event of a spill, operators must file a detailed report on why the spill occurred and how to prevent a recurrence.

Energy efficient house construction

MINING

Our mineral resources fall into two categories: metallic ores and industrial minerals. Metallic ores, which are smelted into metals, include the ores of copper, zinc, nickel, and gold. Industrial minerals, which are generally used in their natural state, include sand and gravel, bentonite, gypsum, limestone, building stone, spodumene, and peat, although treatment, such as crushing or roasting, may be required in some cases.

Manitoba is underlain by rocks of precambrian age that host many mineral deposits. Commonly called the Precambrian Shield, the rocks are exposed over 60% of the surface of Manitoba. In the remaining 40% of the province, the Precambrian Shield is overlain by the sedimentary rocks of the prairies and the Hudson Bay lowlands.

Mining Operations

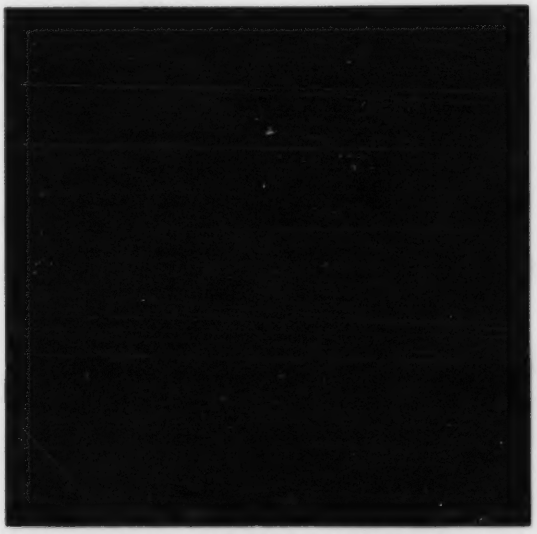
"Hard rock" metal mines are found in the Precambrian Shield, predominantly in three major mining districts. In the Nickel Belt of northcentral Manitoba, Inco Limited produces nickel, copper, cobalt, and precious metals. In the Flin Flon-Snow Lake Greenstone Belt, Hudson Bay Mining and Smelting Co. Ltd. (HBM&S) produces copper, zinc, gold, silver, lead, cadmium, selenium, and tellurium. HBM&S also produces copper, zinc, gold, and silver in the Lynn Lake-Leaf Rapids Greenstone Belt.

The Tantalum Mining Corporation of Canada Limited (Tanco), operates one mine in the Precambrian Shield of southeast Manitoba. Tanco produces spodumene (a mineral used in the manufacture of ceramic cookware) and tantalum (a metal used in high-temperature alloys for machine tools and jet engines). In addition, Cold Spring Granite (Canada), Frontenac Granite (1979), and Canital Granite Ltd. produce building stone at granite quarries in the Precambrian Shield near Lac du Bonnet, Whitemouth, and Medika.

The younger sedimentary rocks that underlie our prairies host several industrial minerals, including limestone for cement and lime, clay for bricks and cement, dolomite limestone for building stone, gypsum for wallboard, quartz sandstone for silica (glass manufacturing), and bentonite clays for clarifying vegetable oils.

Glacial action more than 8,000 years ago led to the formation of numerous sand and gravel deposits in the province. These deposits are mined for the road building and construction industries.

After the last glaciation period, peatlands developed over large areas of Manitoba. Sphagnum peat is mined today by Fisons Western Corporation at the Elma, Julius, Moss Spur, and Evergreen bogs and by Premier West Peat Moss Limited at Giroux and in the Caribou Cluster Bog.



Hudson Bay Mining and Smelting Co. Ltd. in Flin Flon

Looking Back

Tyndall stone was first quarried in 1830 to build Lower Fort Garry, but the first commercial quarry was opened in 1895 at Garson.

By 1886, four brick plants were operating in the province, increasing to 16 plants by 1910.

As early as 1883, small quantities of lignite coal were mined in the Turtle Mountain area and a commercial venture operated during the 1890s.

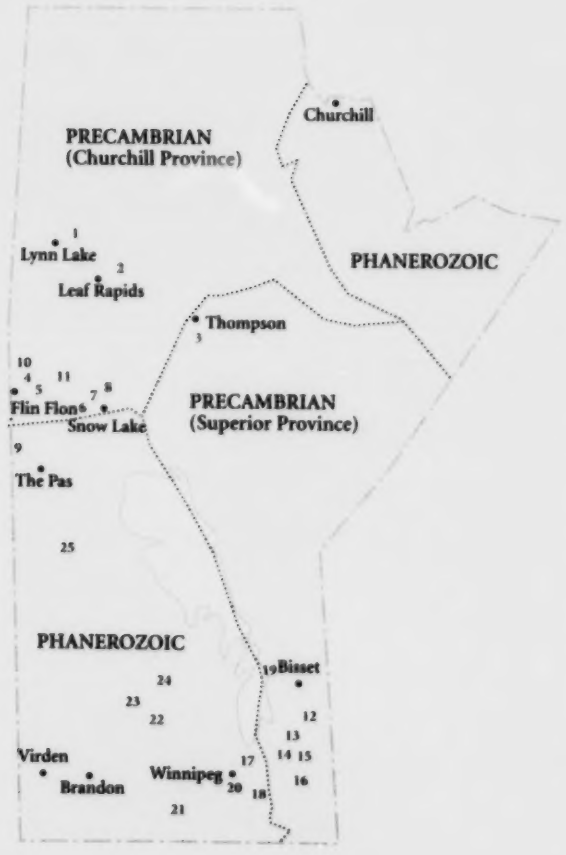
Gypsum was discovered in 1850 and the first plant began operation in 1901.

The first documented gold discovery took place in 1911 and the first base metal deposit – copper – was discovered in 1914 and staked the following year. 1917 saw the first recorded shipment of gold and copper ores. Mining operations slowed in the province from 1919 until 1927 when HBM&S set up a pilot mill at what was to become Flin Flon. By 1930, HBM&S had built a copper smelter and zinc plant to treat ore from the Flin Flon mine and other mines in the area. In 1960, the first of the mines around Snow Lake area was opened by HBM&S.

Salt was mined at Neepawa from 1932 to 1970, and processed into a range of products, from coarse crystals used by packing houses to fine table salt for domestic use.

Nickel was first discovered in Manitoba at Lynn Lake, with production starting in 1953. This was followed by the discovery of the Thompson deposit by Inco Limited in 1956 and the construction of the mining, smelting, and refining complex that first produced electrolytic nickel in 1961.

Mining activities enabled the development of northern Manitoba and the creation of communities of Flin Flon, Snow Lake, Thompson, Leaf Rapids, and Lynn Lake.



Source: Manitoba Energy and Mines

Mines and Quarries (1989)
(excluding aggregate producers)

Metallic Minerals		
1.	Lynn Gold	MacLellan (Au)*
2.	Inco	Thompson Open Pit (Ni Cu)
		Thompson Underground (Ni Cu)
		Birchtree Mine (Ni Cu)
3.	Hudson Bay	Ruttan (Cu Zn)
4.	Hudson Bay	Flin Flon (Cu Zn)
		Trout Lake (Cu Zn)
		Callinan (Cu Zn)
5.	Hudson Bay	Centennial (Cu Zn)
6.	Hudson Bay	Spruce Point (Cu Zn)
7.	Hudson Bay	Chisel (Zn Pb Cu)
	Hudson Bay	Ghost & Lost (Zn Cu Pb)*
	Hudson Bay	Anderson (Cu Zn)*
8.	Hudson Bay	Stall & Rod (Cu Zn)
9.	Hudson Bay	Namew Lake (Ni Cu)
10.	Granges	Tartan Lake (Au) **
11.	Pioneer Metals	Puffy Lake (Au)**
Industrial Minerals		
12.	Tanco	Bernic Lake (spodumene, tantalum)
13.	Cold Spring	(granite)
14.	Fisons Western	Elma (peat)
15.	Frontenac Granite	(granite)
16.	Fisons Western	Elma (peat)
17.	Gillis	Garson (Tyndall stone)
18.	Premier West	Giroux (peat)
19.	Marine Transport	Back Island (silica sand)
20.	Inland Cement	Fort Whyte (clay, cement)
21.	Pembina Mountain	Miami (bentonite)
22.	Westroc	Horcus (gypsum)
23.	Red River	Ste. Rose du Lac (shale)
24.	Continental Lime	Faulkner (limestone, lime)
	Canada Cement	Steep Rock (limestone)
25.	CBR cement	Mafeking (limestone)

* *closed since 1966*
** *opened and subsequently closed since 1966*

Extracting nickel ore from the Pipe Open Pit Mine near Thompson

Mineral Potential

The greenstone belts of Manitoba have been prolific over the years and there is every reason to believe that they will continue to be productive. Namew Lake and Callinan are new mines that opened in 1989. The north extension of the Chisel Lake ore body has been discovered and will be producing in the 90s.

The last few years have seen renewed interest in exploration for gold and there are indications that more interest will be shown in the base metals during the 90s.

In southwest Manitoba, potash deposits have received considerable attention in the last few years because of their value in fertilizer and chemical manufacture. There is little doubt that this resource will be mined when the world market expands and can accommodate an additional source.

Most of Manitoba's peatland remains undeveloped. We have nearly 19,300,000 hectares of peatland, but only 1,254 hectares in southeastern Manitoba are being mined. Manitoba is the third largest producer of sphagnum in Canada behind Quebec and New Brunswick. Ninety percent of the sphagnum is used in commercial greenhouses, mushroom farms, and private gardens.

Impacts

The effects of mining on the environment depend largely on the type of mining and the minerals involved.

Metal Mines

All metal mines, either open pit or underground, produce large quantities of tailings, the finely ground residue that remains after treatment has removed the valuable material. If the ore contain sulphides, oxidation of the tailings together with the leaching action of rain and surface runoff forms sulphuric

Mineral Production (1988)

	Quantity (tonnes)	Value ($ x 1,000)
Metals		
Cadmium	75	1,435
Cobalt	454	8,582
Copper	53,072	167,483
Lead	457	463
Nickel	70,186	1,047,910
Selenium	38	1,049
Tantalum	18	1,695
Tellurium	6	317
Zinc	53,746	88,843
Other*		3,876
Precious Metals (kg)		
Gold	4,469	77,301
Platinum Group		18,051
Silver	32,257	8,634
Total Metals		**$1,425,639**
Industrial Minerals (tonnes x 1,000)		
Cement	409	42,419
Clay Products		2,203
Gypsum	247	3,148
Lime		8,275
Peat Moss	68	8,258
Sand/Gravel	14,189	45,158
Stone	2,877	12,537
Total Industrial Minerals		**$121,998**
Total Minerals/Metals		**$1,547,637**

** Includes cesium, lithium*

Source: Manitoba Energy and Mines

acid which can dissolve heavy metals. This problem is seldom acute when the mine is in production, since the tailings are largely submerged in holding ponds that release alkaline effluent.

Old sulphide tailings from inactive mines can present a major problem. If the tailings are no longer submerged, they oxidize to form acid that dissolves residual metals. Runoff from the tailings can then pollute nearby rivers and lakes.

The former copper/zinc mine at Sherridon is a prime example. Acid formed by the oxidation of sulphide tailings has completely spoiled one small lake and continues to affect part of Kississing Lake. More than $200,000 has been spent on research to find an environmentally sound method of disposing of tailings. Researchers have tried adding ground limestone to tailing ponds and passing runoff through peat moss or over limestone weirs to neutralize the effluent. So far, the research has proved unsuccessful.

Non-sulphide tailings, such as those from most gold mines, do not generate acid. They may, however, contain residues of cyanide or arsenic that can harm fish and other aquatic life. Since the cyanide rapidly breaks down into non-toxic products when exposed to sunlight, the danger to the environment can be averted by storing the effluent in a holding pond until oxidation is complete. Tailings that contain arsenic are disposed of in clay pits and do not pose a threat to the aquatic environment.

More than 40 years ago some gold mines used mercury to extract gold from the ore leaving tailings contaminated with small quantities of mercury. Sometimes the mercury is slowly released into the aquatic system where it is taken up by fish in amounts that exceed the limit safe for human consumption.

All mines also produce large quantities of waste rock that are usually piled on the surface. As in the case of tailings, the waste rock may contain sulphides from which acid can be generated. This is usually minor, since the sulphide content of the waste rock is relatively low, but if the sulphide content is high, or the amount of waste rock extensive, the acid can become a serious problem. During the operation of some mines, a portion of the waste rock is used as backfill in the mine, leaving less surface waste.

After an open pit mine closes, a large open excavation is left behind. Often partially filled with water, the open pit may represent a danger to people. In this case, warning signs are posted and access to the open pit may be restricted by a fence or berm.

On the other hand, an underground mine has only a few small openings that can readily be blocked off with concrete slabs when the mine is closed, for minimum risk. These mines are located in hard rock formations well below the water table, so there is little threat from subsidence or groundwater contamination.

The smelting of sulphide-rich ores releases large volumes of sulphur dioxide and particulates into the atmosphere, contributing to atmospheric pollution. Major sources of air pollution in the province are the smelters at Flin Flon and Thompson (*see* **Air** and **Water**).

Industrial Minerals

The Tanco operation at Bernic Lake is Manitoba's only underground mine that produces tantalum ore and industrial minerals like spodumene. Tailings from the operation are handled in the same manner as tailings from a metal mine: they are stored in a tailings pond. Since sulphide minerals are not present, acid generation will not occur.

Tailings from the mine operation at Lynn Lake. Sulphide tailings can pollute local streams and rivers if runoff from them forms acid and dissolves heavy metals.

All other mining of industrial minerals in Manitoba is carried out in relatively shallow surface excavations rather than underground mines: limestone is quarried at Steeprock, Stonewall, and Mafeking, Tyndall stone is produced at Garson, gypsum is mined at Amaranth and Gypsumville, and silica sand is excavated on Black Island.

Over the years, the aggregate extracted for the construction of roads and buildings has left behind over 5,000 pits and quarries, many of them close to sensitive land uses. Environmental impacts include noise, dust, and vibration from blasting operations, a particular concern where residences are close by. The permanent storage of gasoline and other petroleum products in a pit or quarry is regulated to prevent the contamination of surface and subsurface waters.

A depleted industrial mineral deposit results in an excavation which, while it may not be as large as an open pit metal mine, can be up to 20 metres deep, leaving a scar on the landscape.

Environmental impacts from peat harvesting arise primarily as a consequence of vegetation removal, site drainage, and airborne dust. Peat mining can disturb unique plant communities or rare species, destroy wildlife habitat, and mar the landscape. If the area is drained so the surface is dry enough to harvest the peat, the water table in surrounding areas is lowered, changing vegetation to dryland species. Peat dust can travel up to 48 kilometres, coating leaves and reducing plant productivity.

Legislation and Regulation

Manitoba has legislation that addresses most aspects of mining.

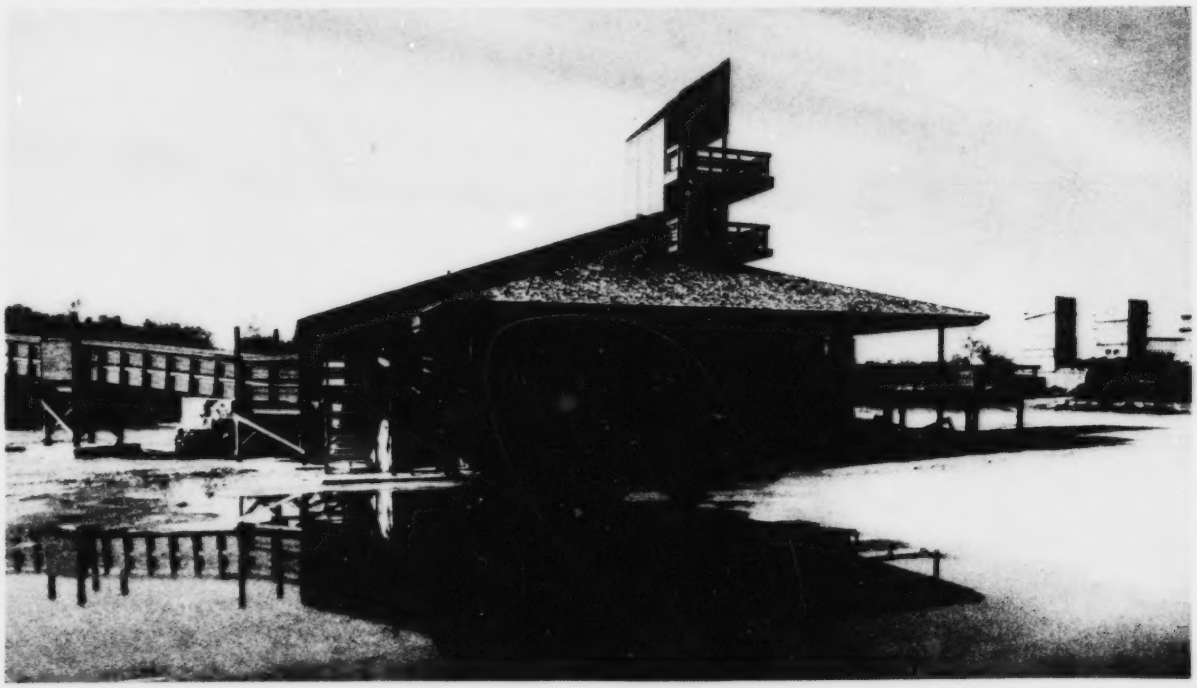
Emissions of sulphur dioxide and particulates from smelting operations are controlled under a regulation of The Environment Act. Manitoba Environment also controls the release of effluents from mining operations by setting limits for effluent.

Manitoba Energy and Mines is currently revising its legislation for the rehabilitation of pits and quarries. Revisions will set limits on emissions of dust, noise, and vibration.

There is no regulation on abandoned tailings that release acid, but Manitoba Environment and Energy and Mines address the rehabilitation of active mines upon their closures. In the meantime, research continues on finding a solution to this problem.

New peat operations are subject to the Environment Impact Review process under The Environment Act.

Stonewall Quarry Park, an interpretive centre that traces the industrial history of the area, overlooks a rehabilitated section of the quarry. Since 1986, about 1,756 hectares of pits and quarries across the province have been rehabilitated.



Minerals Strategy

New policies are being formulated and presented for public consultation under the Sustainable Development Strategy to ensure continued supply and to develop mineral resources in an environmentally sound manner.

Monitoring

As part of its mandate to manage the mineral endowment of the province, the Mines Branch of Energy and Mines monitors mining to ensure that operators are observing correct methods and procedures.

Monitoring ensures that:

- boreholes for exploration are drilled in ways that prevent contamination of groundwater
- mining operations are confined to designated areas
- mined-out areas are rehabilitated
- environmental concerns between the mining industry and the general public are resolved.

The branch also provides input to various decision-making and planning bodies to avoid the loss of aggregate deposits to conflicting land uses.

Trends

Rehabilitation of pits and quarries ——— **Better**
About 1,756 hectares of pits and quarries have been rehabilitated since 1986. Legislation for rehabilitating pits and quarries is being revised to prescribe limits for dust, noise, and vibration, and define physical requirements for rehabilitation such as topsoil replacement, slope angle, and setback from property.

Monitoring of mining operations ——— **Better**
Manitoba Environment and Manitoba Energy and Mines monitor mining operations to ensure that groundwater is not contaminated, the operation stays within its boundaries, and the area is rehabilitated properly at completion. Companies wanting to start new mines must apply to Manitoba Environment for a licence, submit plans for dealing with tailings, and monitor effluents.

Rehabilitation of old tailings ——— **Same**
Tailings from long abandoned mines still pose a threat to the environment. Research continues, so far without success, to find an environmentally sound method of disposing of tailings.

Controlling pollution from tailings ——— **Better**
Under The Environment Act, mines must ensure that effluent discharged into the environment meets standards set out in the licence during operation and upon abandonment.

Gravel pit near Minnedosa. The pit was seeded to a cereal crop after the ground was leveled and the topsoil replaced. Depending on their location, rehabilitated pits and quarries can be returned to their natural state as forests or woodlands, planted with wildlife forage, stocked with fish, or put into pasture or cereal crops.

TRANSPORTATION

Transportation has played a major role in the economic and demographic growth of Manitoba. Canada's major air, rail, and road arteries pass through Winnipeg, which has traditionally served as a primary distribution centre for the prairies.

Railways haul a large proportion of freight to, from, and within Manitoba. They have played a vital role in the province's history and economic development for more than 100 years.

Air transportation is critical to economic development of the major centres in Manitoba and even more so to the northern reaches of the province.

Three statistics help give a further indication of the impact of transportation on the environment and the economy of the province. The manufacture of transportation equipment comprises the second largest segment of industry in Manitoba. CN's Transcona Shops in Winnipeg are considered to be the largest industrial plant in Manitoba. And Winnipeg is the headquarters for nine of Canada's thirteen national trucking companies.

About 1850, the Red River Carts made their appearance, converting the old Indian trails into the first "highways" in the province. The first roads built were scratched from prairie and bush by horse-drawn scrapers, mostly along gridlines to facilitate the transport of grain and other agricultural produce. A network of rural roads was built up and gradually improved, with modern highways following roads developed by the settlers. By the mid 1920s, roads were being pushed into the mineral-rich north. The introduction of motor vehicles made hard surfacing of highways necessary.

Roads and Highways

The province has an estimated 116,000 kilometres of highways and municipal roads as well as 1,640 kilometres of winter roads to transport supplies to northern communities. An estimated 300,000 hectares of land are used for highways, municipal roads, and road allowances.

Over the last 30 years, the number of vehicles registered and the amount of fuel sold have more than doubled. At the same time the number of buses has dropped as a sign that people prefer to take their cars rather than the bus. The number of off-road vehicles - snowmobiles, all-terrain vehicles, and dirt bikes - rose from 45,000 in 1976 to 49,000 in 1980, then dropped to 23,000 in 1986 as a result of rising insurance rates, safety concerns with three-wheelers, and market conditions.

Number of Registered Vehicles

	1956	1966	1976	1986
Passenger cars	172,170	268,801	409,243	524,077
Taxi & liveries	N/A	590	849	785
Delivery cars	2,055	1,938	1,183	621
Farm trucks	31,483	39,606	58,778	67,024
Commercial & public service trucks	N/A	6,359	13,333	27,133
Other trucks	21,080	30,273	71,012	118,654
Public service buses	N/A	242	329	171
Motorcycles & mopeds	1,747	4,822	10,915	17,838
Commercial & P.S.V. trailers	N/A	98	352	1,017
Semi-trailers	N/A	N/A	N/A	2,887
Other trailers	15,155	37,931	73,961	88,465
Licensed tractors	1,987	2,978	265	207
Large snowmobiles	110	190	154	111

Source: Manitoaba Highways & Transportation

Motor Vehicle Fuel Sales Province of Manitoba (litres)

	Gasoline	Diesel Oil	Propane
1956	522,249,096	5,882,863	—
1966	926,247,921	49,144,088	—
1976	1,355,353,538	181,321,968	3,257,369
1986	1,296,201,970	176,087,466	25,332,644
1989	1,341,072,170	219,463,527	27,518,399

Source: Statistics Canada

Rail

Canadian National has some 4,100 kilometres of mainline track in Manitoba, including 820 kilometres from The Pas to Churchill, formerly known as the Hudson Bay Railway. Canadian Pacific's rail network in Manitoba includes 2,050 kilometres of mainline track. VIA Rail Canada operates transcontinental passenger services linking Manitoba with eastern and western Canada. Within Manitoba VIA operates a Winnipeg/Thompson/Churchill service.

Two other railways operate in Manitoba. The Greater Winnipeg Water District Railway, part of the city of Winnipeg's Waterworks Division, and Burlington Northern (Manitoba) Ltd., a subsidiary of the American railway, Burlington Northern of St. Paul, Minnesota.

Total trackage in the province has declined steadily, from 7,621 kilometres in 1966 to 6,306 kilometres in 1986, reflecting the federal government's policy to abandon rail lines that see little use. Over the same period, consumption of diesel fuel gradually increased, from 156 to 240 million litres, reflecting a switch from coal to diesel fuel.

Manitoba's first railway was the St. Boniface/Emerson section of the St. Paul/Minnesota and Manitoba Railway, completed in 1878. From 1880 to 1882, construction of the present C.P.R. transcontinental line (completed in 1885) took place in Manitoba. The present Canadian National transcontinental railway was formed out of several lines built to exploit the tide of settlement into western Canada between 1896 and 1914. By 1914 nearly all of the present-day railways in southern Manitoba were in operation, but lines were built to northern mining communities as recently as the 1950s.

Air

There are about 100 airports/aerodromes in Manitoba, covering an estimated 7,422 hectares. The province operates and maintains 28 airports/aerodromes in northern Manitoba communities, with 19 licensed to airport status.

Between 1985 and 1989, air traffic in the province increased by 38%. It will continue to increase until overland services to northern communities improve.

Land Occupied by Major Airports (hectares)

Winnipeg	1,732
The Pas	1,117
Brandon	809
St. Andrews	574
Thompson	437
Dauphin	278
Lynn Lake	250
Flin Flon	210
Gillam	119

Source: Manitoba Highways & Transportation

Environmental Impacts

Land Loss

Loss of land to roads, railroads, and airports is generally insignificant compared to the total area of the province. Most of the loss, however, has been sustained in southern Manitoba where we have some of our best farmlands and can least afford to lose fish and wildlife habitat.

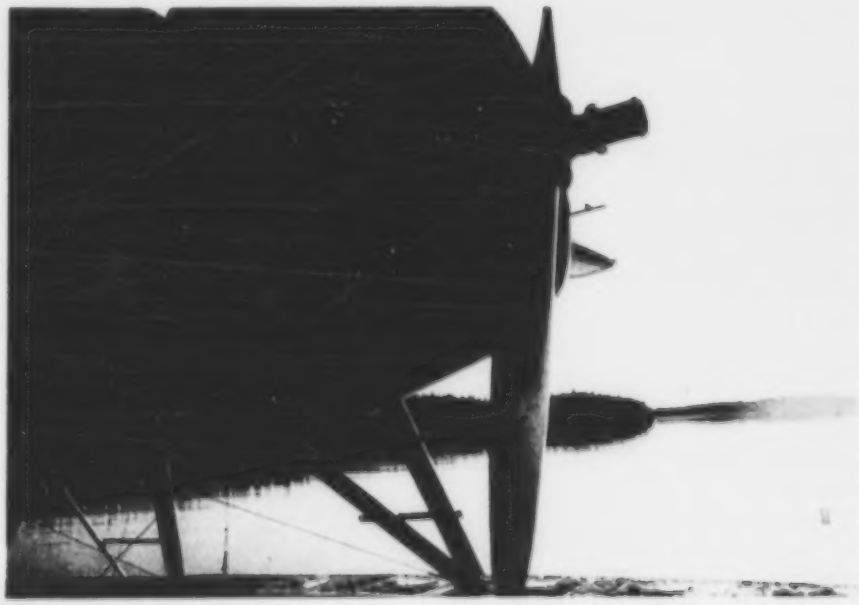
The province has taken several steps to minimize the environmental impact of building, rebuilding, and maintaining transportation corridors. All new projects and proposed upgrading must comply with regulations under The Environment Act. The process ensures that potential environment conflicts are identified, and sensitive areas are either avoided or, where avoidance is impossible, protected by mitigative measures.

All new major highway corridor studies undergo an intensive public review to identify major concerns early in the planning process.

The province has adopted guidelines to help developers and engineers build stream crossings that minimize damage to fish and fish habitats (*see* **Fish**).

A joint Highways-Wildlife Committee, with experts from Manitoba Natural Resources and Manitoba Highways and Transportation, is developing mitigative guidelines for highways construction, maintenance, and operation for release late in 1991.

In some locations, abandoned rail lines, which are generally deeded to adjacent landowners, can be converted to habitat for wildlife.



Until the mid 1920s, aircraft in Manitoba were used mostly by stunt flyers. Starting in 1925, organized air service developed in western Canada, including Manitoba, with most emphasis on northern bush flying. By 1927, there were air bases at a number of communities, including Winnipeg, Lac du Bonnet, and The Pas. A prairie mail service using Winnipeg as a terminus was established in March 1930, but it was discontinued in 1932. Trans-Canada Airlines, now Air Canada, was organized in 1937, with Winnipeg as its headquarters. The first air express service in Canada was started out of Winnipeg in September 1938. The first regular airmail service began in October 1938 and was soon extended to all parts of Canada.

Manitoba Highways and Transportation has revised its highway design standards to reduce the amount of land taken up by rights-of-way. It has also adopted policies to lessen the impact of highway alignment improvements on wetlands, productive agricultural land, and natural woodlands.

In 1990 the department revised its rights-of-way maintenance procedures to protect areas along highways 6 and 1E where remnants of tall-grass prairie have been identified. As well, it is working with Prairie Habitats to rehabilitate medians by planting tall-grass prairie seeds in a test area along highway 75.

Pollution

Chemicals for controlling dust, brush, and ice along highways, railways, and rights-of-way can pollute soil and groundwater. Some of these chemicals decompose slowly, creating problems when they leach into underground water supplies or enter the food chain.

Salt for de-icing roads causes problems nation-wide. Researchers throughout North America are searching for environment-friendly alternatives.

Salt has taken its toll on the province's environment since the late 1940s when it was first used to help keep roads clear of ice and snow. Each year 40,000 tonnes of de-icing salt is spread by crews on provincial and municipal roads across the province.

Although it plays a critical role in making roadways and bridges safe for winter travel, salt has many negative side effects. It corrodes vehicles, reinforced concrete highways, bridges, and other structures. It raises sodium levels in water systems, dries out vegetation, and damages crops with wind-blown spray.

Because of its side effects, traffic authorities are trying to reduce the amount of salt used while searching for less damaging alternatives. "No salt" policies in other jurisdictions have led authorities to conclude that because of a drop in driving safety, the economic cost of not salting far exceeds the economic and environmental costs of salting. Unfortunately, the alternatives to sodium chloride, such as calcium magnesium acetate, sodium formate, and polymeric corrosion inhibitor are prohibitively expensive. They cost up to fifty times as much as salt.

Currently Manitoba authorities minimize the environmental impact of salt by using the least amount for safe driving.

Manitoba Highways and Transportation controls dust with calcium chloride or calcium lignosulfonate which cause less damage to the environment than waste oil which is still used by some municipalities and private landowners.

Manitoba Environment monitors the use of pesticides and herbicides along highways and railways, and at airports. Operators must submit applications and observe restrictions set out in pesticide use permits.

Garbage and Other Eyesores

In addition to accumulations of aluminium cans, bottles, paper, tires, and other garbage along our highways, unattractive developments can represent a form of high-profile pollution. Various highway regulations ensure that proposed developments are assessed in light of their impact on the visual quality of road sides, in addition to environmental, safety, and economic considerations.

For the last few years, Manitoba Highways and Transportation has sponsored a 1-day highway clean-up campaign with Manitoba's 4H Clubs. In 1989, 3,480 club members cleaned 2,194 kilometres of highway and collected 15,205 bags of litter!

Over the last 20 years, Manitoba Highways and Transportation has operated the "Orbit" program to encourage drivers to put their garbage "into orbit" at drop-off points along major highways. The program has helped cut the amount of litter scattered along the highway right-of-way. Handy garbage bags are available at "Orbit" sites for motorists to keep in their vehicles and later deposit in the nearest "Orbit".

Emissions

Emissions from road vehicles boost ambient levels of carbon monoxide and greenhouse gases, and add chemicals to the soil. Lead from leaded gasoline has been found in soils in areas of heavy traffic.

The impact of fuel emissions from aircraft is unlikely to be significant in Manitoba. Air traffic, and its corresponding emissions, are low compared to more heavily populated provinces.

Reliable public transit systems can cut back on the number of cars on the road, reducing amounts of carbon monoxide and other pollutants released. In Winnipeg, taking the bus instead of your car would reduce emissions by 1.5 tonnes per person per year. On a passenger per kilometre basis during peak travel periods, transit buses produce one-eighth the amount of nitrogen dioxide, half the amount of carbon monoxide, and one-sixth the amount of hydrocarbons compared to automobiles. The use of unleaded gasoline has already paid off in lower amounts of lead emitted into the environment (*see* **Air**). Other ways of cutting emissions include flexible working hours and 4-day work weeks which would reduce traffic tie-ups during rush hour. Another measure is to locate work centres in residential areas where employees can walk or cycle to work.

Noise and Safety

With more traffic on the road, noise-related concerns are on the increase in urban centres, particularly in residential subdivisions near to major traffic arteries. Following abandonment of some branch rail lines, truck traffic has increased on rural roads, raising concerns about noise and public safety. The trend toward longer trucks and smaller cars has made travelling more hazardous for car drivers. Transportation of dangerous goods is another safety concern (*see* **Waste Management**).

All land use changes proposed for locations near major highway corridors are reviewed by Manitoba Highways and Transportation to minimize potential conflicts from noise and the transportation of dangerous goods.

Several regulations under The Dangerous Goods Handling and Transportation Act were drafted to avoid hazardous situations from developing.

To block noise in residential areas, treed berms are planted along major roads, and truck traffic is restricted to certain hours and routes.

The obvious environmental impact of air traffic in the south is mainly noise from frequent overflights of areas near airports. Transport Canada cuts down on noise with a range of strategies including:

- distributing arrivals and departures over different runways
- specifying steep aircraft departure angles
- directing departures away from built-up areas
- limiting arrivals to certain times
- pointing engine run-ups away from residential areas
- replacing noisy aircraft with quieter ones.

The Aircraft Noise Operating Restrictions Order (January 1, 1986) and its amendments define operating restrictions on aircraft and noise near airports. Transport Canada operates mobile noise monitoring equipment that checks aircraft noise levels in communities around airports. It uses the information to develop noise abatement procedures.

Fossil Fuel Depletion

The depletion of fossil fuels is addressed in part by conserving energy. There is limited fuel switching simply because most alternatives are fossil-fuel based. People are being encouraged to use gasohol because its emissions have less impact on

the environment than regular gasoline and to take the bus instead of their cars. Transit vehicles are two to six times more energy efficient than automobiles.

The Pupil Transportation section of Manitoba Education and Training has made school buses more "environmentally friendly" by installing coolant recovery tanks that reduce the loss of antifreeze (a toxic substance) and automatic carburettor de-ice systems that improve fuel economy and reduce emissions.

The last few years have seen the recycling of asphalt pavements in several highway surfacing projects. Old pavements are broken up and recycled in new ones for major saving in nonrenewable resources such as asphalt and aggregates. The procedure is expected to become increasingly popular in future.

Recycled oil is currently used in the government vehicle fleet. Provincial staff are encouraged to use radial tires since they last longer and give better gas mileage. Used tires can be recycled into floor mats, mud guards, and tiles.

Legislation and Regulation

A variety of municipal, provincial, and federal laws and regulations control the operation of transportation and transmission arteries. The provincial highway system, for example, is governed mainly by:

- The Highway Traffic Act
- The Highways Protection Act
- The Highways and Transportation Act
- The Dangerous Goods Handling and Transportation Act.

Regulations under The Dangerous Goods Handling and Transportation Act help prevent hazardous situations from developing as a result of the use, handling, storage, disposal, and transportation of dangerous goods.

Staff at Manitoba Highways and Transportation are currently working on a *Strategy on Transportation*, as part of the province's sustainable development initiative.

Trends

De-icing ——— **Same**
To minimize the harmful effects of salt, crews use the least amount needed for safe driving. Research continues throughout North America into finding an environment-friendly substitute.

Loss of land ——— **Worse**
Over 320,000 hectares of land are tied up in highways and roads, railways, and major airports. Although insignificant in terms of the total area of the province, most of the land lost is in southern Manitoba where we have some of our best farmlands and can least afford to lose fish and wildlife habitat.

Airport noise ——— **Better**
Transport Canada takes steps to avoid prolonged noise exposure around airports.

Traffic noise ——— **Worse**
The amount of truck traffic and noise along roads near residential subdivisions is up partly because of the abandonment of railway lines.

Conservation in the transportation sector ——— **Better**
Recycling of oil, radial tires, and asphalt are some of the programs that reduce environmental impacts.

POPULATION

Manitoba, and Canada in general, is fortunate in having a large land area that is sparsely populated. Historically, our low population density may be attributed to a harsh climate and late settlement of the province.

In spite of our severe climate, agriculture thrives in the province. At present, we export most of the grain we produce, more than making up for the amount of food we import from abroad. We are well endowed with a range of natural resources. In addition, our population is growing slowly and could well level off if current trends continue.

Given these elements of the equation, we can reasonably expect that future environmental impacts of the province's population will develop in places where people are concentrated rather than throughout the province from massive numbers of people putting pressure on our forests, soils, and other resources. If impacts prove to be connected more with the distribution of people than with overall numbers, the greatest effects can be expected in the Winnipeg and Grassland regions where concentrations of people are highest.

Although our low numbers are reassuring, it would be well to bear in mind that continued increases in world population can only put pressures on our environment.

Of all animals, the human species has had the greatest influence on the environment, from the localized impact of hunters, gatherers, and early agricultural people, to the country- and continent-wide impacts that started with the industrial revolution, to the global impacts of fossil fuel extraction and the huge energy, nuclear, and space projects that are polluting the oceans and contributing to global warming.

Settlement Patterns

Historically, patterns of settlement in the Grassland and the Broadleaf/Mixedwood Forest regions involved the relocation of Native peoples and were largely shaped by the Indian Act, the Métis Scrip, and the Dominion Lands Act. The location of the railways and the cultural traits of the ethnic groups who arrived during the settlement era before World War I were also important factors.

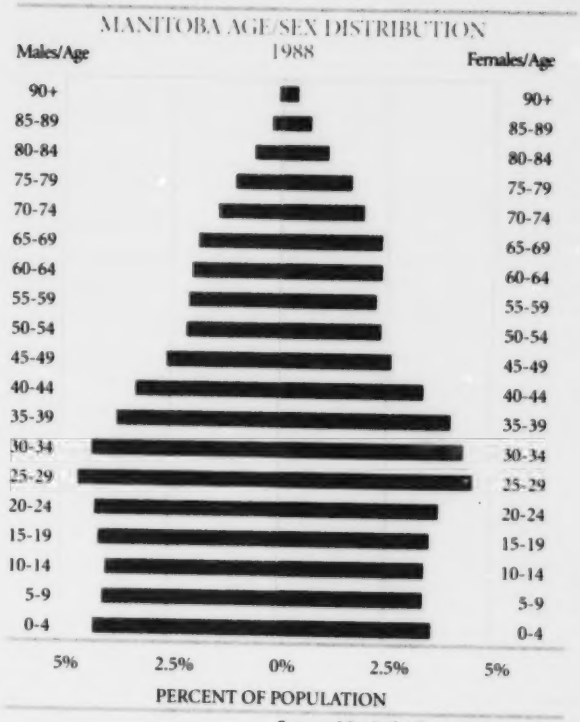
In the Northern Coniferous Forest and the Northern Transition/Tundra regions, mining, forestry, fishing, hydro-electric development, the Hudson Bay Railway, the port of Churchill, and the establishment of Indian reserves have been the prime factors affecting settlement.

Manitoba's population reached nearly 1.1 million in 1990. It had increased steadily from the time of first agricultural settlement of the province, around the turn of the century, until the 1980s when the rate slowed as a result of a downturn in Canada's economy, lower immigration, and a drop in natural increase levels. Manitoba, along with the rest of Canada, now depends on immigration to maintain its population levels.

Age "Vase"

The age structure of the population, especially in rural areas, has changed. Aging and migration of younger people has resulted in greater numbers of seniors, skewing the "age pyramid" into an "age vase." Currently, southwestern rural Manitoba has the highest percentage of seniors in Canada, with 20 to 30% of people over age 65.

Most Manitobans live in the Winnipeg and Grassland regions where populations have grown at the expense of the rest of the province. A "drift" from north to south and from the country to the city is readily apparent. From 1976 to 1986, populations declined by 4.5% in the Northern Coniferous Forest and Northern Transition/Tundra regions.



Source: Manitoba Bureau of Statistics

Region	Percent Changes in Urban and Rural Population 1976 to 1986			Regional Population (thousands)	
	Urban	Rural	Total	1986	1989
Winnipeg	7.6	-72.0	5.9	595	606
Grassland	10.8	2.3	5.6	308	205
Broadleaf/ Mixedwood	2.0	-6.1	-5.0	91	197
Northern Coniferous & NorthernTransition/ Tundra	-6.5	-2.7	-4.5	69	76
Total	**7.3**	**-3.5**	**4.1**	**1,063**	**1,084**

Source: Manitoba Bureau of Statistics, Statistics Canada

Large farming operations and abandoned homesteads are often signs of people moving from the countryside to the cities.

Built in the 1950s, the city of Thompson owes its existence to the discovery of nickel ore deposits.

Agro-Manitoba

From 1976 to 1986, communities in the Central Census Area in agricultural Manitoba grew faster than those in other regions.

If this trend continues, the Central Census Area will be the only rural location where population growth will have an impact on the environment. Brandon and larger towns such as Portage la Prairie, Beausejour, and Dauphin are also likely to grow in the next decade, but the rate would be slow, causing minimal environmental change.

Community Size	**500-999**	**1,000-4,999**
Census Area	**Percent Increase 1976-1986**	
Central	33.0	19.2
Interlake	3.5	14.0
Eastern	2.9	11.7
Southwestern	0.8	1.8
Northwestern	7.0	0.6

Source: Manitoba Bureau of Statistics

Winnipeg, the provincial capital, has grown steadily since the beginning of the century. Most of those who migrate to Manitoba choose to live in Winnipeg.

Northern Manitoba

Barring significant mineral finds leading to new development, little population change can be expected for the Northern Coniferous Forest and Northern Transition/Tundra regions in the 1990s.

As a consequence, environmental and socioeconomic impacts in these regions will continue to be tied mainly to the activities of major companies with interests in the North, such as Inco, Manitoba Hydro, and Hudson Bay Mining and Smelting.

Winnipeg

In 1988, nearly 60% of Manitobans lived in Winnipeg. Between 1983 and 1988, more than 124,000 people left Manitoba. Of these, three out of four were 34 years of age or younger. Yet the city's urban population since 1981 has shown an average annual growth rate of 0.96%, slightly above Canada's average for this period at 0.90%. The higher-than-average rate has been traced to migration from other countries and other provinces, and to a rural-urban shift of the province's Native people.

Between 1981 and 1986 the number of Native households grew from 5.2% of all inner city households to 7.5%. During the same period, the number of visible minority households rose from 8.7% of all inner city households to 13%.

Immigration

Immigrants tend to favour other parts of Canada over Manitoba when they seek a new home. In 1989, for example, only 3.2 % of immigrants to Canada settled in the province, somewhat less than 4.2% which represents Manitoba's proportion of Canada's total population.

Immigration has increased in the last 3 years following changes in federal policy. Of the immigrants who come to Manitoba, 95% decide to live in the cities, and of these 90% pick Winnipeg. The ethnic composition of immigration has also changed. More immigrants now arrive from developing countries, and fewer speak either of our official languages when they reach our shores.

Manitoba's rate of population increase is slightly below the national average. According to a recent federal report, Manitoba's population will eventually drop slightly below present levels if current trends continue. The report also states that, given low natural increases nation-wide, Canada's population is likely to depend on immigration from now on.

World Context

World populations are still increasing at alarming rates, mostly in the developing countries where increases put an added burden on local governments that are working towards better education, health care, and standards of living. If populations continue to increase unchecked, they will outgrow available food resources. The effects of these developments on Canada in general, and on Manitoba in particular, are largely unexplored. Yet it is safe to say that with ever increasing world populations, demands to share Canada's resources with the rest of the world will increase, possibly resulting in greater influxes of people from less fortunate countries.

In addition to "normal" immigration, many immigrants have traditionally been admitted on compassionate grounds, as refugees. As areas of the world face famine and ecological disasters, we may in future need to deal with the problem of "environmental refugees," people from areas no longer able to support their inhabitants.

Environmental Problems

Concentrations of people in larger urban centres, particularly in the lower Red River valley, have caused a range of environmental problems that will need to be addressed in future.

Demand for Fresh Water

Winnipeg draws its fresh water from Ontario's Shoal Lake which is part of Lake of the Woods, an international body of water. A 156-kilometre-long aqueduct supplies a system of reservoirs in and around the city. Since 1919, this source of water has been protected primarily by its isolation and the absence of development pressure around Indian Bay where the water is drawn off. But the supply has now become vulnerable because of nearby cottage and mining developments.

As Winnipeg's population grows, demand for more fresh water will grow with it. Elsewhere in the province, increased demands for water will put more pressures on underground aquifers. Rate modifications could help offset the impact of this demand. Changing rate structures would encourage conservation, reduce consumption, and eliminate the need for a second aqueduct and new reservoirs.

More Wastewater Treatment Needed

In the early 1900s, the arrival of immigrant settlers created a population and real estate boom. Throughout southcentral Manitoba, miles of sewers were installed to serve new residential areas. These "combined" sewers handled domestic sewage and runoff from the streets. Ever increasing volumes of wastewater went directly into our rivers.

Until the 30s, disposing of untreated sewage in our rivers seemed satisfactory. During depression era droughts, however, our rivers dropped and carried proportionately greater amounts of raw sewage. Responding to public concern, the Greater Winnipeg Sanitary District was set up in 1935 to coordinate sewage treatment in surrounding municipalities. Since then, Winnipeg's sewage treatment facilities have undergone frequent upgrading and expansion to meet population growth and more stringent environmental conditions. Ninety-eight percent of Winnipeg's wastewater is now treated.

As water consumption increases, so does the need for wastewater treatment. Monitoring effluents and river water quality is essential to ensure that treatment keeps pace with growth and continues to remove enough pollutants to preserve river quality.

Transportation Effects

The Baby Boom Generation continues to use private cars as a primary means of transport, contributing to air pollution and the depletion of fossil fuels. Other, cleaner means, such as cycling and walking, are still viewed as recreational pursuits.

Greater use of public transit plays a major role in improving air quality. Each year for the last 20 years, people have taken some 55 to 60 million bus rides in Winnipeg, but it is clear that major improvements must be made to the transit system to encourage people to use it instead of their cars. As the residential density of Winnipeg grows more dispersed, traditional service will become increasingly less attractive to many residents. To get more people to take the bus, we will need to provide faster, more reliable, comfortable, and above all, more accessible service that appeals to an aging and geographically dispersed population.

Two- to ten-hectare hobby farms are popular near urban centres.

Demand for More Recreational Development

The concentration of population in the southcentral part of the province has had a great impact on the south basin of Lake Winnipeg, the eastern shore of Lake Manitoba, the Winnipeg River, and Lake of the Woods. Thousands of cottage lots have been subdivided and numerous provincial and private parks developed for recreation. Recently, the Canada-Manitoba Tourism Agreement targeted these areas for more private cottage lots and new resorts.

Pressure for new cottaging and recreational camping in these locations, and for improved infrastructures such as four-lane highways, will continue to increase as Winnipeg grows.

"Rurban" Development

Near larger population centres there is a constant demand for small acreages that often take up productive agricultural land. Communities around Winnipeg, for example, have experienced tremendous population growth in the last 2 decades, particularly in the rural municipalities to the north and east of the city. In contrast to the 1960s when Charleswood and Fort Garry were developed as suburban areas with lot sizes of less than half a quarter hectare, rural residential lots of 1 to 2 hectares are now the norm.

In addition to changing land uses, "rurban" development leads to demands for community clubs, parks, golf courses, and other recreational facilities, as well as new roads, more wells, and more septic systems.

Demand for Environmental Services in Rural Areas

The last few years have seen an upsurge of public concern for the environment. People are changing their lifestyles in the interests of environmental protection and conservation. Demand for recycling centres, pesticide containment depots, hazardous waste depots, programs and projects to protect the environment, and for information on conservation in the home and community, is at an all-time high.

The settlement pattern of the province makes it difficult for provincial authorities to meet this demand in remote and rural communities where people are just as anxious as city residents to protect and conserve the environment.

To bring the people and the environmental services together, Manitoba Environment reorganized in 1990 to increase service to rural and remote centres. Five new regional offices were established, in Brandon, The Pas, Winkler, Steinbach, and Winnipeg. The offices provide one-stop shopping convenience where all departmental services are at the public's disposal, including enforcement, emergency response, monitoring, and community liaison.

Legislation

A host of federal legislation has an impact on Manitobans and their use (or abuse) of the environment. Standards for automobiles and aircraft or controls on grain marketing influence air pollution and farm land use practices. Federal policies and legislation guarantee Treaty Indian rights, control commercial fishing, and direct economic development through regional development incentives, such as the Western Diversification Program.

The primary provincial acts that control and influence settlement patterns in Manitoba are The Planning Act, The Northern Affairs Act, and The City of Winnipeg Act. Much can be achieved by controlling and directing land uses, primarily through the land use policies of The Planning Act.

Municipal governments and the province have numerous programs aimed at managing, maintaining, or improving urban and rural land use. The Northern Development Agreement and Northern Flood Agreement address the development and improvement of northern communities. The Community Places Program, transit subsidies, and housing rehabilitation grants are examples of current programs designed to influence urban development.

"Plan Winnipeg" which is approved by the province under The City of Winnipeg Act directs development in the city of Winnipeg The plan stresses revitalization of the inner city and management of suburban growth, and identifies two major issues for the city:

- the most effective strategy for encouraging the maintenance and revitalization of older, established neighbourhoods
- the most cost-effective location for new neighbourhoods in the suburban area.

Outside Winnipeg, managing settlement patterns is mainly the responsibility of Rural Development and Northern Affairs, while Natural Resources and Agriculture may influence settlement through their control of Crown land uses. Immigration in general is under federal jurisdiction; Manitoba Family Services, through its Immigration and Settlement Branch, is responsible for foreign-born newcomers to the province.

Trends

Impact of populations in communities ———— **Worse**
Concentrations of people in our communities, particularly Winnipeg, are creating more demand for fresh water, wastewater treatment, recreational facilities, and cottage lot development in surrounding areas. Rurban development takes up productive agricultural land and creates more pressure for services and recreational facilities.

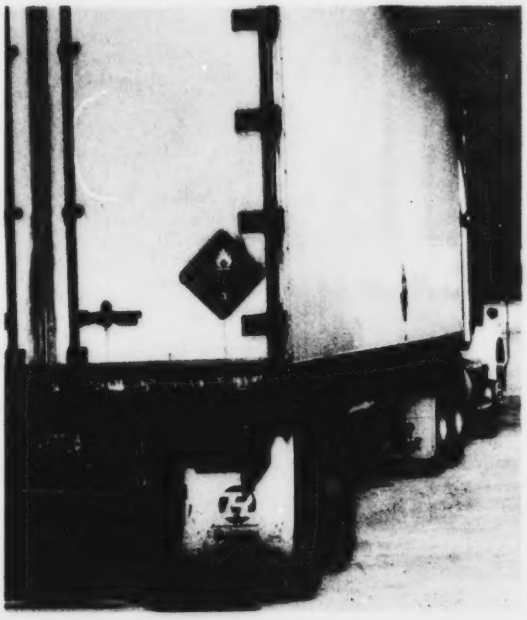
Air pollution in cities ———— **Worse**
Except for lead, air pollution caused by automotive exhausts continues to mount as people choose cars over buses.

Distribution of environmental services ———— **Better**
Manitoba Environment opened several regional offices in 1990 to offer a full range of environmental services to people in rural and remote areas.

LEGISLATION

Numerous acts and regulations protect our quality of life, environmental heritage, and use of natural resources. Chief among them are The Manitoba Environment Act of 1988, The Dangerous Goods Handling and Transportation Act of 1984, The Waste Reduction and Prevention Act of 1990, and The Ozone Depleting Substances Act of 1990. These acts were drafted in response to public demand for strong leadership on local and global environmental issues.

Manitoba continues to cooperate with other Canadian jurisdictions by helping to streamline inter-jurisdictional legislation and by endorsing policies and practices that encourage sustainable development of the economy and the environment.



The province's Dangerous Goods Handling and Transportation Act of 1984 provides a mandate to trace and control hazardous wastes, from cradle to grave.

Environment Act – Legislation for the 90s

The Manitoba Environment Act was developed in response to widespread demand for better environmental protection. It replaced The Clean Environment Act of 1969, the first piece of environmental legislation in Manitoba, which focused mainly on controlling sources of pollution.

Protecting the Environment and the Economy

The goal of The Environment Act is to prevent environmental damage and ensure that Manitoba's environment is protected for future generations. Unique among provincial acts, it covers the permitting process as well as environmental assessments of projects.

Under The Environment Act, all developments that could affect the environment must be carefully assessed for all possible impacts, not only on human well-being and the physical environment but also on the health of the economy. If a development is approved, it is granted an environmental licence and construction or operation can begin.

The Act applies to all developments, whether proposed by government or private industry, whether for a local undertaking or a complex mega-project. It is flexible enough to streamline applications for straight forward, routine developments while requiring broader scrutiny of larger or unique developments.

Public Participation Stressed

The Act recognizes that public participation is crucial to effective environmental decision-making. It encourages public involvement by filing detailed information on proposals submitted for environmental licensing through a network of public registries located throughout the province. It provides for public input through the work of the Manitoba Clean Environment Commission which conducts formal investigations into environmental issues, holds public hearings in the review and assessment of proposed developments, and acts as an environmental mediator in cases of environmental conflicts.

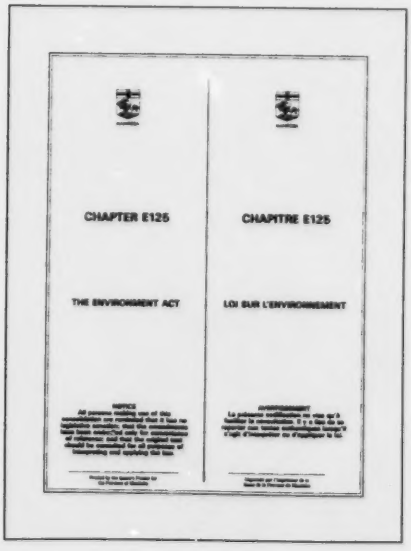
The need to involve the public led to the formation of the Manitoba Environmental Council which represents a varied cross-section of public interest and expertise on environmental matters drawn from across the province. Members of the council provide advice and recommendations on environmental matters, promote environmental awareness, and help develop and present environmental education programs.

Under the Act, a State of the Environment Report must be published every 2 years. The report is designed to keep Manitobans informed on the state of the province's environment and promote responsible management of our resources.

Enforcement and Administration

The Act provides penalties for non-compliance, ranging from personal liability through fines and jail sentences. The maximum fine for individuals is $100,000. The maximum fine for corporations is $1 million with provisions for cleanup and restitution, suspension of operating licences, and confiscation of profits from non-compliance with the legislation.

Administration and enforcement of the Act is the responsibility of Manitoba Environment. Enforcement staff in the department have the authority to conduct inspections and take emergency action.


CHAPTER E125

THE ENVIRONMENT ACT

CHAPITRE E125

LOI SUR L'ENVIRONNEMENT

Protecting the Environment – Sharing the Responsibility

The federal and provincial governments share the legislative responsibility for protecting the environment. Each has developed environmental management legislation and administrative processes to fulfil its mandate. Since this can result in overlap and duplication of environmental assessments, the two governments often enter into agreements to coordinate their efforts.

Interjurisdictional Cooperation

To further this interjurisdictional cooperation, the Canadian Council of Ministers of the Environment adopted the *Statement of Interjurisdictional Cooperation on Environmental Matters*, in March 1990. The statement calls for a commitment by each government to:

- act while respecting the jurisdiction of other governments
- recognize each other's strengths and capabilities
- cooperate in a spirit of partnership
- provide timely notification and appropriate consultation where one jurisdiction's legislation, policies or programs affect those of another jurisdiction.

Eliminating Jurisdictional Overlaps

Environmental assessments are growing in popularity as a means of making decisions on projects, with the result that jurisdictions have developed their own comprehensive legislation to cover the process. Unfortunately, some of this legislation has been successfully challenged in the courts, raising the spectre of more and more complicated legislation and procedures to cover loopholes.

A healthy environment and economy depend on the confidence of the public and those who invest in projects that are subject to environmental assessments. The people and groups involved must be confident that an effective and timely assessment process is in place. It is also critical that the assessment process be cost effective, minimize overlap and duplication, and encourage cooperative action.

Manitoba is working, along with other jurisdictions to develop common elements of environmental assessment and review, and to establish mechanisms to ensure effective, rational, and compatible processes across the country.

Main Acts and Regulations

Here is a listing of selected acts and regulations that affect our use of the environment. For highlights on key acts and regulations that apply to specific aspects of the environment, check the various sections of this report. All Manitoba acts and regulations are available from the office of the Queen's Printer.

FEDERAL

Atomic Energy Control Act (1946)

Canada Shipping Act (1989)
- c. 1487 Small Vessel Regulations (1978)
- c. 1407 Boating Restriction Regulations (1978)

Canadian Environmental Protection Act (1988)

Fisheries Act (1985)

Game Export Act (1941)

Historic Sites and Monuments Act (1953)

Manitoba Fishery Regulations (1987)

Migratory Birds Convention Act (1985)

Migratory Birds Regulations (1990)

National Parks Act (1988)

Transportation of Dangerous Goods Act (1985)
- Transportation of Dangerous Goods Regulations (1985, 1989)

PROVINCIAL

The City of Winnipeg Act (1989)
- 439/88 Designated Floodway Fringe Area

The Dangerous Goods Handling and Transportation Act (1984)
- 2336/89 Anhydrous Ammonia Handling and Transport
- 282/87 Classification Criteria for Products, Substances and Organisms
- 439/87 Environmental Accident Reporting
- 141/87 General
- 140/88 Generator Registration and Carrier Licensing
- 139/88 Manifest Regulation
- 474/88 PCB Storage Site

The Dutch Elm Disease Act (1987)
- 15/88 Dutch Elm Disease

The Ecological Reserves Act (1990)
- 142/89 Ecological Reserves Designation
- 499/88 Ecological Reserves

The Endangered Species Act (1990)

The Environment Act (1988)
- 88/88 Amy Street Heating Plant
- 89/88 Campgrounds
- 164/88 Classes of Development
- 125/88 Designation of Critical Areas
- 90/88 Disposal of Whey Regulation
- 91/88 Incinerators
- 181/88 Inco Limited and Hudson Bay Mining and Smelting Co., Limited Smelting Complex
- 301/88 Licensing Procedures
- 92/88 Litter
- 93/88 Livestock Production Operation
- 226/89 Peat Smoke Control
- 94/88 Pesticides
- 418/88 Private Sewage Disposal Systems and Privies
- 284/89 Pulp and Paper Mills Liquid Effluent Discharges, Repeal
- 126/88 Sensitive Areas
- 97/88 Storage and Handling of Gasoline and Associated Products
- 98/88 Waste Disposal Grounds

The Fires Prevention Act (1987)
- 20/86 Fire Alarms
- 102/87 Fire Hose
- 110/88 Manitoba Fire Code 1987
- 103/87 Property Insurance Assessment

The Fisheries Act (1987)

The Forest Act (1987)
- 226/88 Designation of Provincial Forests
- 227/88 Forest Use and Management

The Gas Pipe Line Act (1987)
- 246/88 Gas Pipe Line Construction Standards
- 337/88 Gas Pipe Line Excavations

The Gas Storage and Allocation Act (1987)

The Groundwater and Water Well Act (1987)
- 123/89 Well Drilling

The Heritage Resources Act (1986)
- 160/89 Heritage Objects Designation
- 227/89 Heritage Resources Forms
- 271/89 Heritage Sites Designation

The High Level Radioactive Waste Act (1987)

The Highway Traffic Act (1985, 1986)
- 162/87 Equipment and Mechanical Fitness Standards of Vehicles
- 53/89 Fitness Requirements for Commercial Trucks and Drive-Yourself Vehicles Order
- 77/89 Used Household Goods
- 292/89 Vehicle Weights and Dimensions on Classes of Highways

The Highways and Transportation Act (1987)
- 196/89 Abandonment of Provincial Roads
- 246/89 Abandonment of Provincial Roads (Access Roads)
- 58/89 Abandonment of Provincial Trunk Highways
- 412/88 Construction and Surface Maintenance of Access Crossings to Departmental Roads
- 245/89 Declaration of Provincial Roads (Access Roads)
- 195/89 Declaration of Provincial Roads
- 97/89 Declaration of Provincial Trunk Highways

The Highways Protection Act (1987)
- 569/88 Control Lines Establishment and Limited Access Designations
- 39/87 Limited Access Highways Application Fee
- 42/89 Permits for Location of Structures in Controlled Areas

The Manitoba Hazardous Waste Management Corporation Act (1986, 1987)

The Manitoba Hydro Act (1987)
- 244/86 Standards of Wiring
- 186/90 Terms and Conditions of Supply of Power

The Mines Act (1987)
- 435/87 Lands Re-opened to Prospecting Orders 1975-1987
- 56/87 Lands Withdrawn from Prospecting Order
- 48/89 Lands Withdrawn from Prospecting Orders
- 427/87 Mineral Disposition, 1974
- 475/88 Mineral Disposition, 1981
- 589/88 Minerals Treatment in Canada Exemption
- 429/87 Petroleum Crown Leasing
- 153/89 Petroleum Crown Royalty and Incentives
- 430/87 Petroleum Drilling and Production
- 432/87 Petroleum Geophysical
- 432/87 Potash Exploration Permit
- 573/88 Quarrying Minerals, 1976

The Noxious Weeds Act (1987)
- 214/87 Noxious Weeds

The Ozone Depleting Substances Act (1990)

The Pesticides and Fertilizers Control Act (1977)
- 215/87 Herbicide "Goal" in Commercial Onions
- 302/87 Pesticides and Fertilizers Licence
- 46/86 Sale and Use of Herbicide Randox

The Planning Act (1987)
- 85/88 Northern Manitoba Planning Procedures
- 480/88 Provincial Land Use Policies
- 419/88 Subdivision

The Provincial Park Lands Act (1972)
- 223/86 Certain Activities in Whiteshell Provincial Park
- 539/88 Park Lands Activities
- 137/89 Park Lands Fees
- 35/89 Park Lands Withdrawn from Local Governments
- 229/89 Provincial Park Lands Establishment and Use
- 19/88 Subdivision of Land
- 373/87 Use of Vehicles in Spruce Woods Provincial Heritage Park

The Public Health Act (1987)
- 320/88 Atmospheric Pollution
- 332/88 Barbershop and Hairdressing Establishments
- 390/88 Bedding, Upholstered and Stuffed Articles
- 337/88 Care Facilities
- 321/88 Collection and Disposal of Wastes
- 338/88 Diseases and Dead Bodies
- 322/88 Dwellings and Buildings
- 339/88 Food and Food Handling Establishments
- 323/88 Fumigation and Pest Control
- 334/88 Hotels
- 324/88 Ice
- 335/88 Industrial and Construction Camps
- 325/88 Insanitary Conditions
- 326/88 Protection of Water Sources
- 340/88 Public Health Interpretation and Personnel
- 336/88 Rags and Other Material
- 327/88 Recreational Camps
- 328/88 Sanitary Areas
- 329/88 Swimming Pools, Wading Pools, Modified Pools and Non-Conforming Pools
- 330/88 Water Supplies
- 331/88 Water Works, Sewerage and Sewage Disposal
- 341/88 X-Ray Safety

The Rivers and Streams Act (1988)

The Tourism and Recreation Act (1987)
- 487/88 Transient Accommodation Facilities

The Waste Reduction and Prevention and Consequential Amendments Act (1990)

The Water Resources Administration Act (1987)
- 23/88 Designated Flood Areas
- 22/88 Designated Reservoir Areas
- 24/88 Establishment of Designated Dyking Systems

The Water Rights Act (1988)
- 19/90 Water Rights

The Wildlife Act (1990)
- 46/90 Activities in Wildlife Management Areas
- 215/89 Amphibians and Reptiles
- 26/88 Compensation for Hunter-Killed or Injured Livestock
- 73/89 Compensation for Loss or Damage to Crops by Migratory Game Birds
- 28/87 Designation of Nature Centres
- 57/90 Designation of Wildlife Management Areas
- 33/88 Fur Dealers, Tanners and Taxidermists
- 162/89 Game Hunting Areas
- 225/89 General Hunting
- 211/89 Hunting Seasons and Bag Limits, 1989-1990
- 36/88 Licensing of Game Bird Farms and Game Bird Shooting Preserves
- 32/88 Oak Hammock Waterfowl Control Area and Oak Hammock and Grants Lake Managed Hunting Areas
- 208/85 Placing of Bait Near the Hudson Bay Coastline
- 36/88 Raccoon Dog and Nutria
- 52/89 Refuge
- 31/88 Serving Meat of Wild Animals
- 29/88 Special Conservation Areas
- 18/89 Training and Use of Dogs for Hunting Wildlife
- 259/89 Trapping and Snaring Seasons
- 183/89 Trapping Licence Fees, Royalties and Areas
- 258/89 Use of Guides in Hunting
- 210/89 Use of Vehicles for Hunting
- 352/88 Waterfowl Bait Station Zone
- 198/89 Wildlife Crop Damage Compensation
- 268/89 Wildlife Fees and Royalties

The Workplace Safety and Health Act (1987)
- 40/86 Construction Industry
- 99/88 Derrick, Crane and Other Hoisting Equipment
- 100/88 Fibrosis and Silicosis
- 101/88 First Aid
- 102/88 Forestry, Logging and Log Hauling
- 103/88 Hearing Conservation and Noise Control
- 62/87 Operation of Mines
- 53/88 Sanitary and Hygienic Welfare
- 105/88 Workers Working Alone
- 52/88 Workplace Hazardous Materials Information System
- 131/89 Workplace Health Hazard
- 106/88 Workplace Safety and Health Committee
- 107/88 Workplace Safety and Health Forms
- 108/88 Workplace Safety

Testing at the Technical Services Laboratory. The results of chemical analyses and tests performed at the lab are presented as evidence at legal and quasi-legal proceedings and are for use in scientific publications and reports by staff of Manitoba Environment.

A Look at the Public Registry

All proposed projects that could have an impact on the environment must be approved for licensing under The Environment Act. Part of the approvals process is a review by staff at Manitoba Environment and all involved provincial departments. Relevant information on the project must also be on file for people to examine at public registries located in Brandon, Dauphin, Flin Flon, Morden, Portage la Prairie, Selkirk, The Pas, Thompson, and Winnipeg.

If granted, a licence may specify conditions of construction or operation which the proponent must obey to ensure that the proposed project will not cause environmental degradation and that the operation is consistent with the principles of sustainable development.

Projects are classified according to the magnitude of their potential environmental impact, from Class 1 (least) to Class 3 (greatest). From June 1989 till July 1990, Manitoba Environment received 123 applications for review: 42 for Class 1 projects, 77 for Class 2, and 4 for Class 3. Here is a representative cross-section of projects from that review period to give some indication of the depth and extent of the review process and how it works.

Four-laning of Provincial Trunk Highway #1 near Oak Lake (Class 3)

This four-laning project was proposed by Manitoba Highways and Transportation. In keeping with guidelines issued by Manitoba Environment, Highways listed potential impacts on surface water and groundwater, fish, wildlife, and heritage resources, the impact of vehicle emissions, and socio-economic factors. Highways also conducted a public meeting in Oak Lake to address concerns raised by landowners. Information was deposited in the public registries in Brandon and Winnipeg, a technical advisory committee of representatives from various provincial departments reviewed the project, and Manitoba Culture, Heritage and Citizenship conducted an archeological survey of the area.

During the review, Manitoba Agriculture voiced a general concern about criteria for acquiring land for future service roads. A technical committee of representatives from the involved departments was struck to prepare guidelines to address this concern.

The project was licensed as proposed. Its design parameters and construction procedures were filed with Manitoba Environment, for use in inspection or enforcement.

Birtle-Harrowby 230 kV Transmission Line (Class 2)

This 70-kilometre-long transmission line was intended to supply a proposed potash mine in western Manitoba. Hydro's application included a comparative assessment of seven alternative routes.

Following a review of the submission by Manitoba Environment and by a technical advisory committee, a licence was issued for the preferred alternative route.

Conditions of the licence specify that the applicant must:

- carry out a heritage resource impact assessment before construction
- consult with Manitoba Natural Resources on making use of cleared timber and protecting stream crossings
- refrain from spraying of the right-of-way near water courses

- minimize damage to wetlands and vegetation
- revegetate the right-of-way with native species.

Deago Properties Sewage Treatment Plant (Class 2)

Deago Properties applied for a licence to construct a sewage treatment plant to serve a proposed urban-residential subdivision in East Selkirk. Effluent from the plant was to be released into Cooks Creek.

During the review and public notification process, Manitoba Environment received objections to the project and a request for a public hearing. The Minister of Environment directed the Clean Environment Commission to hold a public hearing on the proposal.

The Commission noted that although the proposal itself was sound, it had not been assessed in a regional context. Further, the capacity of Cooks Creek to assimilate effluent from the plant, now and in future, had not been adequately addressed. It recommended against approval of the application, noting that similar future proposals should include a review of municipal wastewater disposal needs, options, and capabilities. The licence was denied.

Oak Hammock Fish Farm, R.M. of Rockwood (Class 1)

Oak Hammock Fish Farm proposed to build a 2,800,000-litre dugout, and a settling pond, to be used for a fish farm. The technical review considered the stability of the settling pond, where the waste water would go, the need to control pelicans and cormorants that might prey on the fish, and the fate of the dugout and settling pond if the operation closed down. The applicants were advised that they would not be issued permits to kill pelicans or cormorants, and that they must submit technical details on pond construction. It turned out that the applicants proposed to irrigate their fields with waste water from the operation. The licence was issued on condition that the applicants obtain a Water Rights Licence from Manitoba Natural Resources.

Prendiville Wood Preservers Ltd., Neepawa (Class 1)

Prendiville has operated a wood treatment plant for posts and lumber since 1979. In the past, because the operation did not include drip pads, soils at the plant were contaminated with preservative - a highly toxic cocktail of chromic acid, copper oxide, and arsenic pentoxide.

The review of the operation included inspection of the premises and sampling of soil and water. The licence cites more than 20 conditions that Prendiville must meet in running the operation and handling material. A continuing water and soil monitoring program has been set up at the plant to ensure that no contaminants enter the environment from now on.

The review has led to a series of environmental monitoring programs carried out jointly by Manitoba Environment and the rest of the province's wood preservative industries.

The Prendiville Wood Preservers site

Trends

Environmental legislation ——————— **Better**
Manitoba's Environment Act is one of the most advanced of its kind in the country.

Complexity of acts and regulations ——————— **Worse**
Despite the quality of environmental legislation, its sheer volume and extent of application makes interpretation difficult.

Effort to simplify, strengthen legislation ——————— **Better**
The province works in cooperation with other provincial governments and the federal government to establish uniform environmental legislation across the country, and to ensure its uniform interpretation.

Access to information ——————— **Better**
Public registries give the public easy access to information on new developments that apply for an environmental licence. All members of the public are entitled to present their views at public hearings or through submissions to Manitoba Environment.

EDUCATION

The future of our environment depends on the efforts of people in all walks of life, particularly our young people who will become tomorrow's decision makers.

As a participant at the Land and Water Strategy meetings put it: "If conservation of soil and water is to become a way of life, it must be taught in our schools. A whole new generation is coming up."

Several representative examples of environmental education programs and resources for a range of audiences are highlighted in this section. These programs do more than instruct participants in the techniques of environmental conservation and protection. They are designed to foster respect for the environment and encourage all of us to work for a cleaner, greener world.

For details on programs that apply to specific areas of the environment, see other major sections of the report.

Project WILD's mission is to help youngsters learn* how *to think - not* what *to think.

Project WILD

Project WILD is an environmental and conservation education program designed specifically for youth. It covers activities easily integrated into classes on science, social studies, language arts, mathematics, and art. The material is also useful for scout leaders, outdoor education camp personnel, and park naturalists.

Activities are organized under major topic headings: awareness and appreciation; diversity of wildlife values; ecological principles; management and conservation; people, culture, and wildlife; trends, issues, and consequences; and responsible human actions. Topics were chosen with input from educators, conservationists, wildlife managers, and representatives from business and industry. Techniques for teaching them were developed by educators and extensively field-tested.

Project WILD provides information from a variety of sources to help students evaluate choices and make reasonable decisions. Its overall purpose is to motivate youngsters to take intelligent and constructive action to conserve wildlife and natural resources. Wildlife is emphasized because of its intrinsic and ecological values, and its importance as a basis for understanding the fragile ground on which all life rests.

In Canada, Project WILD is sponsored by the Canadian Wildlife Federation. It was originally developed by the Western Association of Fish and Wildlife Agencies and the Western Regional Environmental Education Council in the United States. The Wildlife Branch is responsible for bringing the program to our schools, with help from citizens groups, teachers, and Manitoba Education and Training.

SEEDS

SEEDS stands for Society, Environment, and Energy Development Studies. A federally-chartered, non-profit, education foundation, SEEDS was organized in 1976 to help build a society that understands and is committed to actions leading to the wise stewardship of resources, resource use, and the environment. It has a nine-member board, with people from education, industry, and the social/environmental sciences. SEEDS is supported through the donations of industry, business, government, and private foundations. Over 1,000,000 Canadian students have used SEEDS programs.

The Energy Literacy Series, one of SEEDS' most successful programs, explores the scientific, social, and environmental impacts of energy use. Topics range from the sun and fossil fuels to sources of electrical energy and energy in the future.

Another program, Learners in Action, encourages students to act at school, at home, and in the community.

Who's Responsible?

In 1988, the Manitoba Hazardous Waste Management Corporation produced *Who's Responsible?*, a video on hazardous waste issues and the need to develop an environmentally sound disposal system for the province. Other educational tapes produced by the corporation include *PCBs: Are They Harmful?*, *Hazardous Waste Management: Challenge of the Decade*, *Household Hazardous Waste*, *Our Throw-Away Society*, and *Industrial Waste: A Challenge We Must Meet.*

The corporation helps to educate Manitobans about waste management with its resource kit for Manitoba teachers with suggested activities for kindergarten to grade 12. Activities are designed to educate students that "we are all part of the hazardous waste problem." Topics range from trash and litter to recycling and waste disposal. Corporate staff make follow-up visits to field questions from the students.

"Clean It Up", a board game about pollution designed for children in grades 4 to 6. It was created in 1989 by two grade 7 students, Cheryl Sylvester and Kim Nichol. It took two years to complete and the girls hope it will teach children about noise, land, water, and air pollution, and encourage them to protect the environment. Up to four children can play, collecting tokens for good environmental deeds such as repairing a broken car muffler and cleaning up the yard, and losing tokens for environmental crimes such as dumping garbage in lakes and spewing industrial smoke into the air. The game will be produced for use in Manitoba schools as part of the science curriculum in 1991.

Deloraine's "Conservation in the Classroom" Series

Rick Schoonbaert and Dale McKinnon, two science teachers at the Deloraine Collegiate Institute, along with the Turtle Mountain Conservation District, have brought conservation into the classroom with three projects designed to promote student awareness of local conservation issues and prepare them to deal with environmental problems. The projects form part of the ecology units of their science classes and are marked for credit.

Information generated by the projects complements the district's long-time commitment to environmental conservation which began in the mid 60s when the district was formed. The district has pledged financial support through prizes and bursaries for outstanding effort.

Projects are designed for grades 7, 9, and 12. Grade 7s identify resource problems and solutions using their farms, yards, or towns as study areas. Grade 9s catalogue resources in their area, identify the need for conservation, and develop a plan of action – activities that are common to development of a resource management plan for the district. Grade 12s address air and water pollution problems as part of their chemistry studies. They compare local pollution issues with those at a provincial, national, and global level.

The pilot project has entered its second year as an ongoing part of the science curriculum. According to Schoonbaert, "The kids really get involved in the projects because of the hands-on activities."

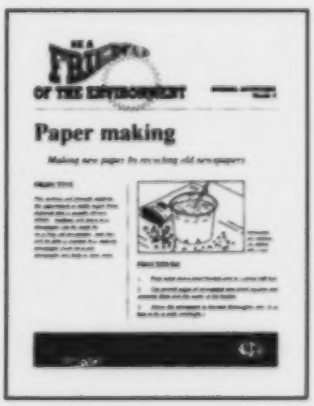
Manitoba's School System

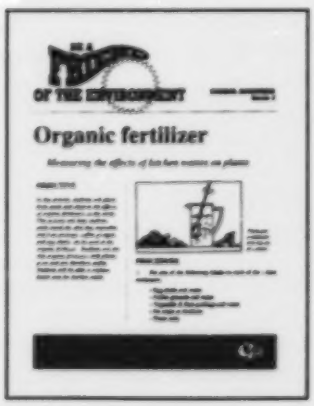
In Manitoba's schools, the concept of sustainable development is being integrated into the curriculum across all grade levels. Science textbooks, currently being developed for grades 7, 8, and 9, will emphasize sustainable development concepts and issues.

Manitoba Education and Training works closely with agencies and organizations to identify and review environmental resource materials and makes them available to schools. In addition, Education and Training cooperates in the development of new materials. Examples of these activities include:

- *Be A Friend of the Environment* - a made-in-Manitoba series of booklets focusing on recycling and waste reduction. Produced by Manitoba Environment for use with children from kindergarten to grade 4, it features resource information on topics ranging from sustainable development to the 4 Rs (reduction, reuse, recycle, and recover). Activities for all ages include a school recycling project, an environmental quiz, and an environmental lifestyle assessment.
- ***Green Beginnings*** - an environmental series for elementary students, focuses on how each person can make a difference in the environment. Students, working in pairs, research different environmental problems and present the results to their classmates. Topics range from acid rain, the greenhouse effect, and the ozone layer to water pollution, rainforests, and dangerous chemicals.
- ***Before It's Too Late: Urgent Messages About Conservation*** - an audio-visual program dealing with soil and water conservation. The program was produced by Manitoba Educational Television (METV) in cooperation with Manitoba Natural Resources.
- ***Who's Responsible?*** - an audio-visual program focusing on Manitoba companies that are recycling their wastes and reducing their use of hazardous products. The program was developed by the Manitoba Hazardous Waste Management Corporation in concert with METV.
- ***Soils: The Living Blanket*** - a series of eight programs provides an indepth look at the nature and importance of conserving soils. It was produced by METV in cooperation with Assiniboine Community College and Manitoba Television Network.

Organizations such as the Fort Whyte Centre for Environmental Education, the Manitoba Naturalists Society, and Manitoba Soft Drink Recycling Incorporated also serve as important resources for many schools.

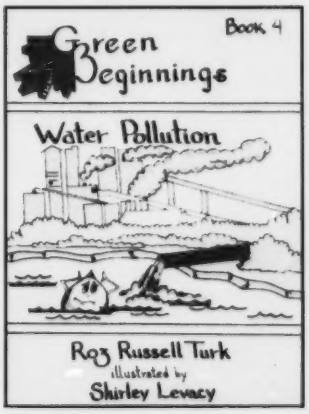


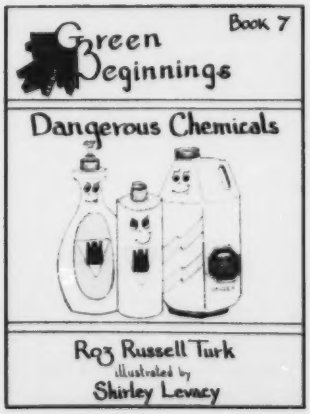


Post-Secondary Education and Training

Manitoba's colleges and universities are also reinforcing environmental content in their programs. In some cases they are taking a lead in recycling and other conservation efforts on campus. Examples of these activities include:

- Assiniboine Community College has established a college-wide collection and recycling system for its office paper, and is developing a new Grower Pesticide Safety program for farmers.
- Keewatin Community College has integrated sustainable development into its natural resources management technology program. The Student Association Council at the college recycles aluminium cans.
- Red River Community College recently revised its biological technology program to include many environmental courses. The college has set up a pilot project to study the environmental impacts of paper recycling in government.
- Brandon University offers such courses as pollution biology and human impact on the environment and recycles metal and paper on campus.
- The University of Manitoba offers environmental courses on a range of topics including conservation issues, pollution biology, ecological impact assessment, biogeochemistry, and conservation strategies. The Natural Resources Institute offers courses on natural resource economics, public participation in decision making, and biological or mineral resource management. The university recycles office paper and aluminium cans, with plans to expand to plastic and glass. From June to December of 1990, 17.1 tonnes of office paper was recycled with help from student volunteers. The Recycling and Environmental Group at the university sells reusable Eco-mugs that give owners discounts on purchases of coffee and reusable Re-wrap Bags for "wrapping" presents instead of using wrapping paper.
- At the University of Winnipeg, courses offered through the Environmental Studies program include resource management and planning, modern environmental problems and attitudes in urban setting, environmental ecology, and landscape classification/parks planning. Newspaper, aluminium cans, office paper, and laser printer cartridges are recycled.





Booklets in the "Be a Friend of the Environment" (previous page) and "Green Beginnings" series stress hands-on activities in recognition that students learn best by "doing."

Fort Whyte Centre for Environmental Education, one of Canada's premier interpretive facilities, is visited by more than 100,000 Manitobans and visitors to the province each year. Lafarge Canada Inc. and the Fort Whyte Foundation Inc. developed 80 hectares of clay pits, forest, and meadows into a year-round interpretive centre with fresh water aquarium, self-guided trails, nature library, and prairie soil diorama. More than 30,000 school children enjoy the hands-on environmental education programs each year.

Environmental Education Facilities

Manitoba supports several world-class environmental education facilities, including:

• ***Fort Whyte Centre for Environmental Education*** - Programs for kindergarten to grade 12 are based on Manitoba's science curriculum and cover such topics as winter survival, habitat studies, and sustainable living. The interpretive centre houses a touch museum, an aquarium with Manitoba freshwater fish, and a waterfowl wintering room. Outdoors projects include the compost trail, birdfeeding station, and self-guiding trails.

• ***University of Manitoba Field Station*** - Delta Marsh Field Station provides a setting for the study of marsh ecosystems, winter ecology, and population dynamics at the post-graduate, undergraduate, and high school levels. The station is also open to seminars, workshops, group bookings, and visitors.

• ***Delta Waterfowl and Wetlands Research Station*** - Research covers marsh management, waterfowl production, and the importance of wintering grounds.

• ***Sandilands Forest Centre*** - Grade school students and their teachers take part in hands-on learning programs to explore and experience the forest environment. Facilities include a museum, a tree identification building, and a nursery.

• ***Duck Mountain Forest Centre*** - The centre is open to school classes, tourists, organizations, and senior citizen groups. The school program covers ecological studies, identification of plants and animals, and forest protection.

• ***Oak Hammock Marsh Wildlife Management Centre*** - Visitor services include an information centre, observation mounds, and a seasonal nature interpretation program. The interpretation program focuses on the importance of wetlands and marsh management.

• ***Manitoba Museum of Man and Nature*** - The museum loans out to schools Edu-Kits that cover topics ranging from insects, plants, rocks, and minerals of Manitoba to the lifestyles of Natives and early settlers. Touch the Universe, planetarium shows, and temporary programs and exhibits dramatize the marvels of science and the solar system.

• ***Ducks Unlimited Canada*** - Ducks Unlimited has a library of videos and films, on waterfowl, wildlife, agricultural land management practices, and the general environment. The library is available to schools, wildlife and conservation clubs, sportsman groups, 4H clubs, and other organizations.

Woodlands demonstration at the 4P Festival, a 3-day event held at Pine Falls every September long weekend to celebrate power, paper, pickerel, and peas. Abitibi-Price extends invitations to all visitors to tour the mill and attend the logging and forest renewal demonstrations. The number of visitors has increased nearly ten-fold from the 30 who attended the first tour in 1981 to nearly 300 in 1990.

Trends

Environmental education programs ——— **Better**
Energy Literacy Series, Project WILD, Be a Friend of the Environment, and special classroom projects such as the one at the Deloraine Collegiate Institute are examples of environmental education programs and resources in Manitoba.

Environmental education facilities ——— **Better**
Manitoba has several world class environmental education facilities that offer a variety of information for public use, from films, videos, and literature to interpretive tours, hands-on projects, and seminars.

Public attitudes ——— **Better**
Public attitudes toward environmental issues have improved through programs available in schools, colleges, and universities, and from environmental facilities such as the Fort Whyte Centre for Environmental Education, forest centres, research stations, and Oak Hammock Marsh Wildlife Management Centre.

SUSTAINABLE DEVELOPMENT

Sustainable development has rapidly become a watchword for describing efforts to reverse the deterioration of the earth's life-support systems and ensure that our future is environmentally and economically sustainable.

The term gained international credibility following release of a report by the United Nations' World Commission on Environment and Development in 1987. The Brundtland Report, named for Norwegian Prime Minister Gro Brundtland who chaired the commission, did not propose banning all development and returning the environment to its original pristine state – which would be impossible in the industrialized world. Instead, it proposed "a new era of environmentally sound economic development" and used the term "sustainable development " to describe the link between the environment and the economy. According to the Commission: "Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."

At the core of the concept is the idea that we need to maintain or improve our resource and environmental base so that future generations will be able to live equally well or better.

One Manitoba farmer summed up the concept this way:

"My father left me the farm in the late 1950s," he said. "He wanted me to leave it to the next generation in as good or better shape than I found it. That's what I intend to do and that is what sustainable development means to me."

Turtle Mountain Conservation District, one of six conservation districts in the province. In rural Manitoba, conservation districts are considered one of the best means of implementing sustainable development in keeping with local concerns and priorities.

Recycling tire rubber in Winkler

Sustainable Development in Action

Sustainable development takes many forms. A manufacturing company cuts costs by upgrading its production line and in the process reduces emissions that can harm the environment. A government department creates a program for restoring degraded environments and stimulates the economy by opening up job opportunities.

Here is a cross-section of projects to show how Manitobans in the public and private sectors are using these and other approaches to put the principles of sustainable development into action.

Manitoba Leads R-2000 Concept

One of the compensations for living in a cold province is that we lead North America in building energy-efficient homes. Manitoba now has the greatest number of super-efficient homes per capita in North America. The program continues to grow, with better heating, ventilation, insulation, and other design features forming a "prescriptive standard for R-2000 home registration."

St. Amant School Wins Recycling Prize

The students and staff of St. Amant School in Winnipeg began an aluminum can and soft drink bottle recycling project 2 years ago in hopes of raising $3,000 in 3 years. They planned to use the money to build wheelchair access to their playground. They surpassed their goal in just 22 months, and are now raising money for playground equipment.

The school's efforts won them the first Recycling Challenge sponsored by Manitoba Environment, Manitoba Education, Manitoba Soft Drink Recycling Inc., the Consumers Association of Canada, and the Recycling Council of Manitoba.

Winkler Firm Recycles Tire Rubber

A Winkler entrepreneur has found a way to recycle used tire rubber into useful products. He uses his own shredding machine to trim away the non-steel portions of used tires, and separates the material into fibrous rubber strands. The fibres can then be used to make mats, tiles, and automotive mud guards. It may even be possible to blend the rubber into asphalt for road construction. The Pembina Valley Development Corporation assisted by investigating market opportunities and studying alternative uses for the recycled rubber.

Farmers to Benefit from Conservation Scheme

Conservation-minded farmers in Manitoba could profit from a program being developed under the North American Waterfowl Management Plan. The program involves spending $1.5 billion over the next 15 years to help farmers co-exist with ducks that feed on crops and live in the marshy margins of fields. The scheme will also play a major role in soil conservation. Large areas of marginal farmland sown to crops could be more productive if used for wildlife habitat, particularly when the land is prone to erosion when cropped. By paying farmers to raise ducks instead of crops, the plan will boost incomes and conserve soils.

Environmental Soundness and Profitability

Winnipeg Photo and Perth Services received a salute from The Canadian Green Consumers Guide for taking recycling seriously. Winnipeg Photo installed new processing equipment that paid for itself almost immediately while substantially reducing amounts of disposable chemicals. Perth Services has also cut costs and reduced the likelihood of waste solvents entering the water system by installing new equipment that reclaims solvents.

Fort Whyte Centre for Environmental Education

An environmental education centre in southwest Winnipeg visited by more than 100,000 Manitobans and tourists every year was formerly an area of clay pits used by Lafarge Canada Inc. With the help of the company and the Fort Whyte Foundation Inc., the pits were developed into an 80-hectare nature centre with meadows, woodlands, marshes, lakes, self-guided trails, and a variety of wildlife.

An award-winning interpretative centre features several major exhibits that support environmental education programs. A new sustainable living program focuses on composting, energy use, environment/economy relationships, and environment-friendly shopping.

Sustainable Development Strategy

A document titled *Towards a Sustainable Development Strategy for Manitoba*, outlines the framework, fundamental principles, and guidelines that will be followed throughout the process of incorporating the concept of sustainable dvelopment into all aspects of provincial economy, resource utilization, and conservation. This "core document" and its component strategies, for which policy documents and implementation plans will be proposed, will undergo extensive public consultation with revisions finalized at the end of 1991.

The Brundtland Report noted that progress in sustainable development "...depends, perhaps more than in any other field, on the support of an informed public opinion. That, in turn, depends on open forms of examination and assessment and on the free flow of resulting information."

In 1989, in recognition of the crucial role of public involvement in the search for ways and means of achieving sustainable development, the provincial government launched the first of the component strategies identified by the core document.

The Land and Water Strategy is one of a series of continuing public consultation programs to develop and refine policies for managing the province's natural resources in a sustainable fashion.

To date, more than 2,000 Manitobans, from all walks of life, in communities throughout the province, have attended meetings and workshops to help forge policies for developing the economy while conserving our natural resources. Participants showed enthusiasm for the consultation process. "We feel involved," was a typical response. "It's about time this happened!"

Time and again, people at the meetings expressed concern about the way we seemed to be using up our resources as if there were no tomorrow. They felt that if things kept going like that, there would not be anything left. They wanted to do something before it was too late.

They admitted that they wanted to enjoy what we have, but not to the point where future generations would not be able to enjoy it too. As one man put it: "I want to be able to go swimming in our lakes and rivers without worrying about pollution. I want to be able to get a decent job. And I want the same for my children."

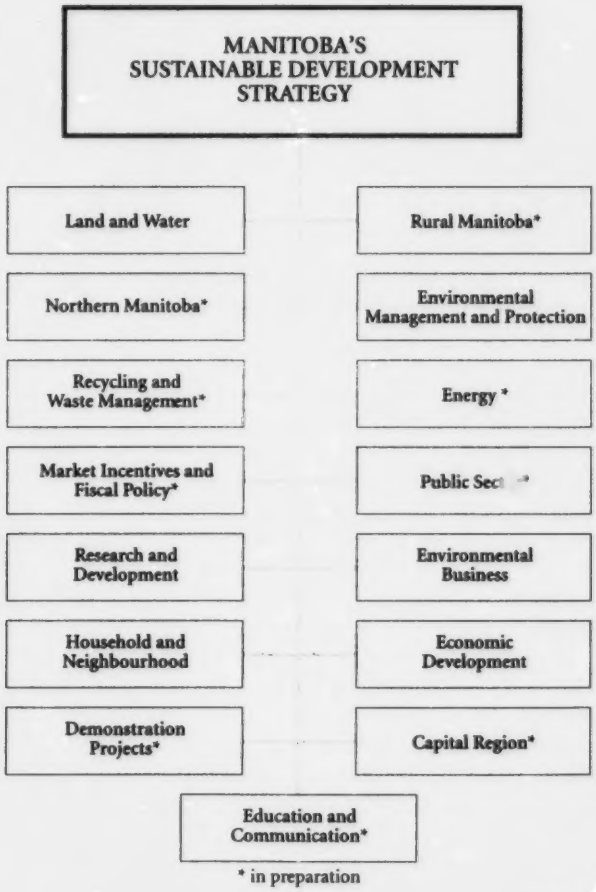
Conserving the environment while developing the economy for a better quality of life was the challenge they proposed to take on, with the provincial government as facilitator.

The Land and Water Strategy is not the only strategy for conserving our environment while creating economic activity. The idea is to manage all aspects of our environment and economy to ensure a sustainable future for the province.

Workbooks to facilitate public consultation. Draft policies for managing our soils, water, forests, and minerals had been reviewed by several thousand participants in all walks of life at meetings throughout the province.

Topics to follow include:

- *agriculture*
- *transportation*
- *recreation*
- *wildlife*
- *fisheries*
- *other resources.*



They stressed the need for local involvement in planning and implementing programs. They wanted government participation, but in the form of direction and consultation rather than dictation. "Give us guidance and direction, but give us the big stick only when we need the big stick."

As workshops to address other resources continue, they are expected to yield more and more ideas that will culminate in programs and initiatives designed to ensure a sustainable future for the province.

Principles and Guidelines for Sustainable Development

Sustainable development itself is the subject of draft principles and guidelines intended to form the cornerstone of the province's sustainable development strategy in the 1990s and beyond.

The principles and guidelines will be refined with the help of a public consultation process designed to encourage the participation of all Manitobans.

Principles of Sustainable Development

1. Integration of Environmental and Economic Decisions. This principle requires that we must ensure economic decisions adequately take into account environmental consequences, including human health, and that environmental initiatives adequately take into account economic consequences.

2. Stewardship. This principle requires that we manage the environment and economy for the benefit of present and future generations. Stewardship requires the recognition that we are caretakers of the environment and economy for the benefit of present and future generations of Manitobans. A balance must be struck between today's decisions and tomorrow's impacts.

3. Shared Responsibility. This principle requires that all Manitobans acknowledge responsibility for sustaining the environment and economy, with each being accountable for decisions and actions, in a spirit of partnership and cooperation.

4. Prevention. This principle requires that we anticipate, prevent, or reduce the significant adverse environmental (including human health) and economic impacts of policies, programs, and decisions.

5. Conservation. This principle requires that we maintain the essential ecological processes, biological diversity, and life support systems of our environment; harvest renewable resources without exceeding sustainable yields; and make wise and efficient use of our renewable and nonrenewable resources.

6. Recycling. This principle requires that we endeavour to reduce, reuse, and recover the products of our society.

7. Enhancement. This principle requires that we enhance the long-term productive capability, quality, and capacity of our natural ecosystems.

8. Rehabilitation and Reclamation. This principle requires that we endeavour to restore damaged or degraded environments to beneficial uses. Rehabilitation and reclamation require ameliorating damage caused in the past. Future policies, programs, and developments should take into consideration the need for rehabilitation and reclamation.

9. Scientific and Technological Innovation. This principle requires that we research, develop, test, and implement technologies essential to furthering environmental quality, including human health and economic growth.

10. Global Responsibility. This principle requires that we think globally when we act locally, in recognition that there are no boundaries to our environment and that there is ecological interdependence among provinces and nations. There is a need to work cooperatively in Canada, and internationally to accelerate the merger of environment and economics in decision-making and to develop comprehensive and equitable solutions to problems.

Guidelines for Sustainable Development

1. Efficient Use of Resources. We shall encourage and support the development and application of systems for proper resource pricing, demand management, and resource allocation together with incentives and disincentives to encourage the efficient use of resources and the full environmental costing of decisions and developments.

2. Public Participation. We shall establish appropriate forums that encourage and provide opportunities for consultation and participation in decision-making processes by all Manitobans. We shall endeavour to ensure that due process, prior notification, and appropriate and timely redress for those affected by policies, programs, decisions, and developments.

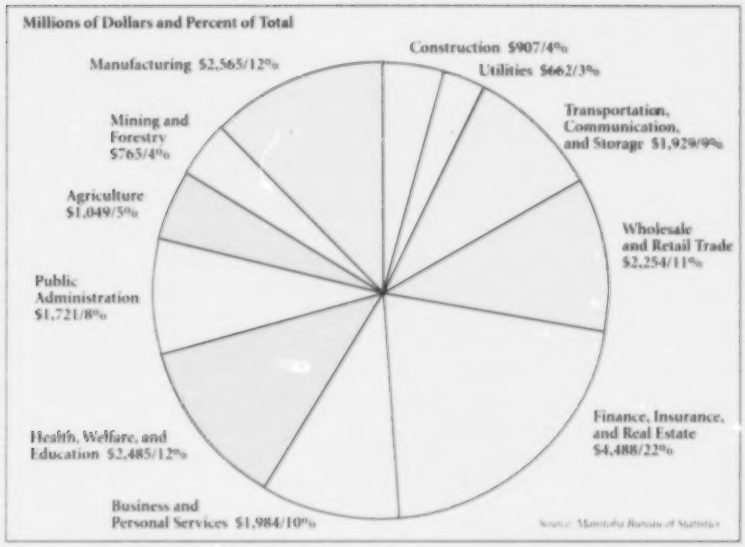
3. Understanding and Respect. We shall be aware that we share a common physical, social, and economic environment in Manitoba. Understanding and respect for differing social and economic views, values, traditions, and aspirations are necessary for equitable management of these common resources. Consideration must be given to the aspirations, needs, and views of various regions and groups in Manitoba.

4. Access to Adequate Information. We shall encourage and support the improvement and refinement of our environmental and economic information base and promotion of the opportunity for equal and timely access to information by all Manitobans.

5. Integrated Decision-Making and Planning. We shall encourage and support decision-making and planning processes that are open, cross-sectoral, incorporate time horizons relevant to long-term implications, and are efficient and timely.

6. Substitution. We shall encourage and promote the development and use of substitutes for scarce resources where the substitutes are environmentally sound and economically viable.

Major sectors of Manitoba's economy. The pursuit of economic gain often carries an environmental cost, here as well as everywhere else.


Millions of Dollars and Percent of Total
Construction $907/4%
Utilities $662/3%
Manufacturing $2,565/12%
Transportation, Communication, and Storage $1,929/9%
Mining and Forestry $765/4%
Agriculture $1,049/5%
Wholesale and Retail Trade $2,254/11%
Public Administration $1,721/8%
Finance, Insurance, and Real Estate $4,488/22%
Health, Welfare, and Education $2,485/12%
Business and Personal Services $1,984/10%

Conserving the Environment While Developing the Economy

In the past the economy and the environment were viewed as mutually exclusive concerns. This is no longer considered an option. The challenge is to conserve and enhance our resource base while generating economic activity – which is the challenge of sustainable development.

Here is a brief look at four sectors of the economy to show how the province's industries are meeting the challenge of sustainable development. For details on the efforts of people in different sectors of the economy, *see* **Agriculture**, **Forests**, and other sections of the report.

Food and Beverage Industries

The food and beverage industries constitute the greatest proportion of Manitoba manufacturers, contributing 25% of the total volume of manufacturing shipments. Although widely dispersed in Agro-Manitoba, generally in communities, they can cause problems with solid and liquid waste, odour, and dust.

Among the worst offenders are the "wet" industries that use large quantities of water and release large quantities of effluent to rivers and streams. Communities are responding by upgrading their treatment facilities and tightening controls over sewage disposal.

Packaging used by the food processing industries and the retail/service sector is a major source of solid wastes and non-biodegradable solids. Some types of polystyrene packaging for fast food and for shipping cushions use chlorofluorocarbons (CFCs) as blowing agents for expanding foam beads. CFCs have been singled out as the leading cause of deterioration of the ozone layer and a factor in the greenhouse effect. Manufacturers and users of polystyrene are responding by choosing benign foamants. The Ozone Depleting Substances Act of 1990 prohibits the manufacture and sale of products harmful to the ozone layer.

Construction

From 1983 to 1989, the construction of facilities for generating and distributing electrical power, as well as residential, commercial, and institutional construction, contributed about 5% of the gross domestic product in the province.

The building industry is not seen as a major polluter of the environment, since much of its potentially negative impact is prevented by zoning regulations and land use planning.

On the minus side, the industry draws on aggregates, fossil fuels, and wood for raw materials. But increasing environmental awareness and the need to conserve energy have led to changes in the building code, with the result that most new buildings are now more energy efficient than ever before.

The construction of roads, transmission lines, or large hydroelectric power generation projects can have positive and negative impacts on the environment and the economy by:

- pre-empting agriculture, forestry, and other land uses
- bringing about changes in land use, from blocking or facilitating access, to forcing changes in harvesting methods
- stimulating the economy, such as by creating employment and generating revenue for the province
- opening up recreational opportunities affecting the well-being and lifestyles of people
- affecting plant and animal populations, and water supply and quality.

Under The Environment Act, all such projects require a licence from Manitoba Environment and may be subject to public review and hearings.

Services

The service sector comprises a wide range of activities, including transportation, finance, government, trade, and personal services. It employs the greatest number of people – over 70% of average total employment in Manitoba.

Most services are distributed fairly evenly throughout all regions, with the exception of financial services which are concentrated in Winnipeg.

Service-oriented businesses generally produce few pollutants. Although they consume resources, consumption is generally limited to paper for office use or publications.

Health care establishments generate hazardous wastes such as used drugs, solvents, and infectious materials. Some hospital waste includes low level radioactive materials. Treatment of wastes from hospitals is regulated under the provincial Dangerous Goods Handling and Transportation Act.

The trade sector has started responding to the public's demands for environmental protection and sustainable development. Marketing of "green products" in retail stores is one example. Recyclable shopping bags and a return to non-disposable diapers are others.

The government exerts considerable influence on the environment and our use of it through legislation, support programs, and education. In this respect, educational institutions exert a similar influence.

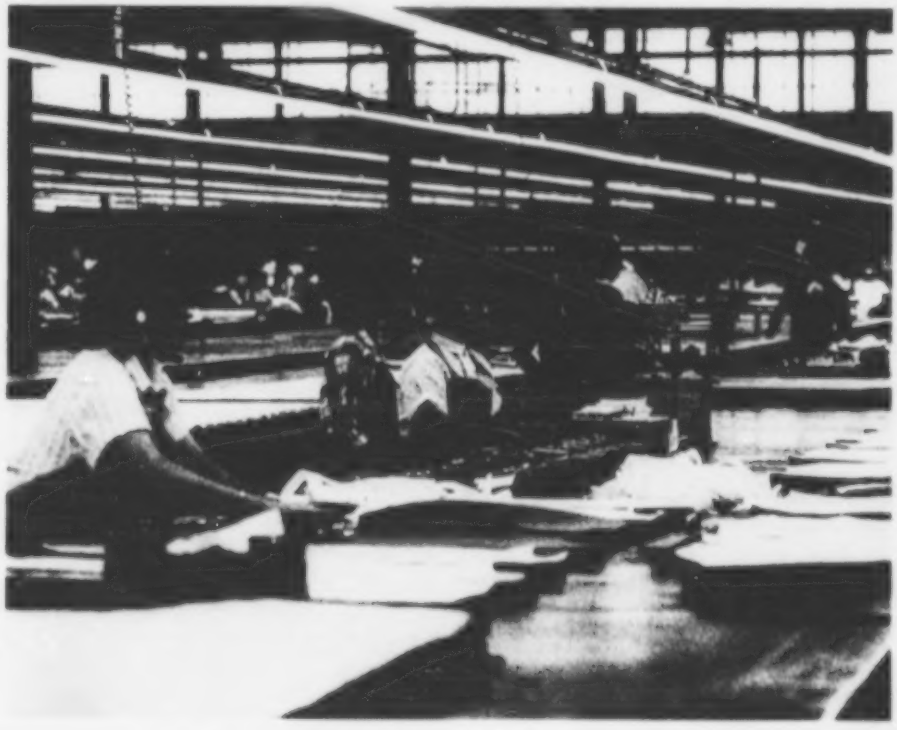
Tourism

By certain criteria, tourism is considered to be the third largest industry in Manitoba. In 1986, tourists made 7,548,300 trips to and within Manitoba and spent $667,800,000 in the province.

Tourists who visit Manitoba often take a sightseeing tour of Winnipeg and other cities and towns. But the main attraction is still our unspoiled wilderness settings. The economic base of our tourism industry rests squarely on natural resources. Without clean air and water, healthy forests and wildlife, and uncrowded spaces, the industry could not exist. Therein lies its major dilemma - serving enough tourists to make ends meet without exceeding the carrying capacity of the countryside.

The sustainability of the resources that tourists seek is of major concern to those who operate tourist spots. Some fishing lodge operators, for example, allow their guests no more than one trophy fish to take home. Others insist that all fish be released, and supply guests with fillets from commercially caught fish instead!

Many Manitobans and people from outside the province enjoy visiting our provincial parks (*see* **Special Areas**). To accommodate their diverse demands, Manitoba Natural Resources zones parks for different kinds of recreational activities. The Whiteshell, for example, has a wilderness zone where motors are not allowed, and an extensive recreation zone where commercial harvesting is allowed because it provides a major source of income to people living in the region.



"Footloose" industries illustrate the global interdependence of all human activity. They are industries located in Manitoba mainly because of skilled workers and cheap electricity. An example is the garment industry which imports nearly all of its raw materials. Since these raw materials constitute a natural resource of another country, they deserve to be utilized sustainably - no less than our own resources. Unfortunately, the province has no control over their exploitation, although Canada may have some influence through its foreign policies.

Economic Indicators

In the long term, our well-being can be maintained only if the resources on which our economy depends are developed and used sustainably.

Key Indicators

The gross domestic product – a key indicator of economic growth – is the total monetary value of all goods and services produced in the province. In Manitoba, the gross domestic product rose during most of the 80s, even when adjusted for inflation, reflecting real economic growth.

Business and industry gave the province a vote of confidence during the 80s. In 1989 dollars, investments during the decade rose 26.9%, from $2.5 billion to $3.2 billion.

Over the same period, the unemployment rate declined, by 1.7% between 1983 and 1986, then remained reasonably stable for the rest of the decade. Average weekly earnings dropped by 4.8%, but per capita disposable income rose by 11.3%. However, the consumer price index, a measure of the average change in prices over time of basic consumer goods and services, rose from 116.1 in 1983 to 142.1 in 1989.

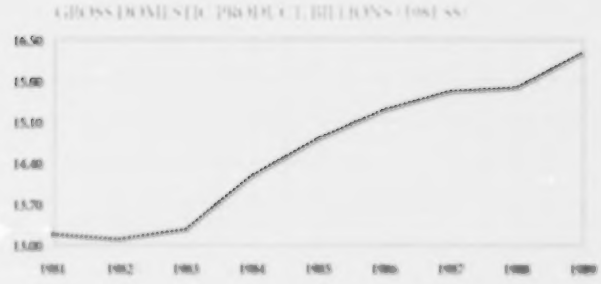
Environmental Effects

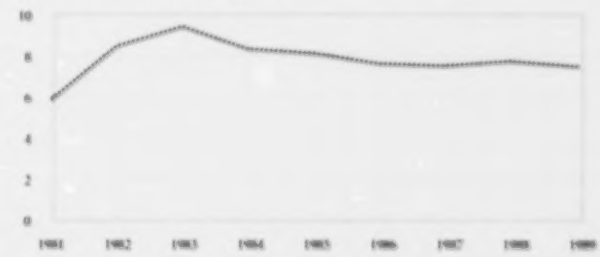
Although economic indicators have been used consistently for many years, they can be misleading because in many cases they fail to take into account the environmental costs of economic progress.

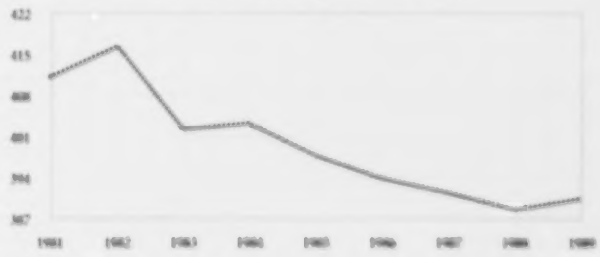
In recent years, the concept of the gross domestic product has been under attack because of an inherent weakness. Although the concept takes into account the depreciation of buildings and equipment, it does not include the depreciation of our greatest assets – our renewable and non-renewable natural resources. Whenever an economic gain is realized from the unsustainable use of a resource, the real measure of progress is lower than that indicated by the gross domestic product.

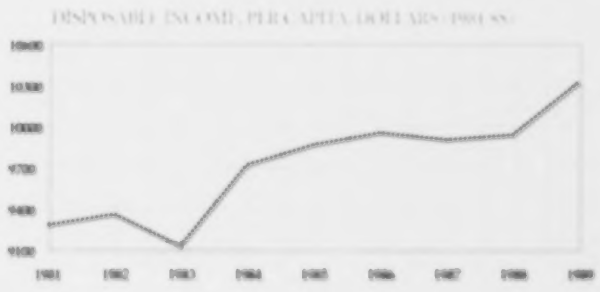
On the positive side, a healthy economy brings a high standard of living, with economically stable businesses and households that are often more able and willing to channel some of their wealth into environmental programs.

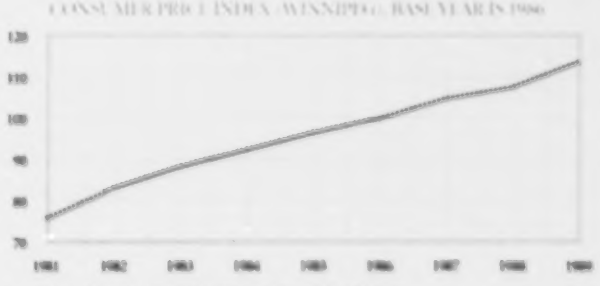
"If a farmer is doing well, he is more likely to take an interest in conservation tillage, residue farming, and other environmentally friendly practices, than a farmer who is reduced to eating his seed potatoes and worrying whether he will have a farm next spring."











Source: Manitoba Finance, Manitoba Industry, Trade and Tourism

Conservation Districts – Sustainable Development Since the 70s

Sustainable development was at work in Manitoba long before the term was coined. In the early 1970s, it took the form of conservation districts, under a program with a mandate to manage our land and water resources with tomorrow's needs in mind.

Group of Neighbours

A conservation district is a group of neighbouring municipalities working together to manage the natural resources of their area. Each district has a board of local representatives chosen by member municipalities to conduct the business of the district.

Manitoba currently has six conservation districts:

- Alonsa, on the west shore of Lake Manitoba
- Cooks Creek, just east of Winnipeg
- Pembina Valley, in southcentral Manitoba
- Turtle Mountain, in southwestern Manitoba
- Turtle River, near McCreary east of Riding Mountain National Park
- Whitemud, on the eastern slopes of the Manitoba Escarpment.

25% of Agro-Manitoba Involved

Nearly 2 million hectares of Manitoba farmland – about 25% of Agro-Manitoba – benefit from the conservation districts programs. The districts have delivered some $30 million worth of programs and projects in the past 20 years.

Soil management, water storage, erosion control, agricultural land drainage, habitat enhancement, and conservation education are typical of programs favoured by the province's conservation districts. Programs are developed with the help of the province, but each district is in the driver's seat when it comes to planning, setting priorities, and carrying out programs in response to its own needs.

Up to three-quarters of the cost of conducting conservation districts programs may be paid with grants from the province. The rest of the money is generally raised by each district, which may receive gifts and donations, and negotiate funding with such agencies as Ducks Unlimited Canada and Agri-Food.

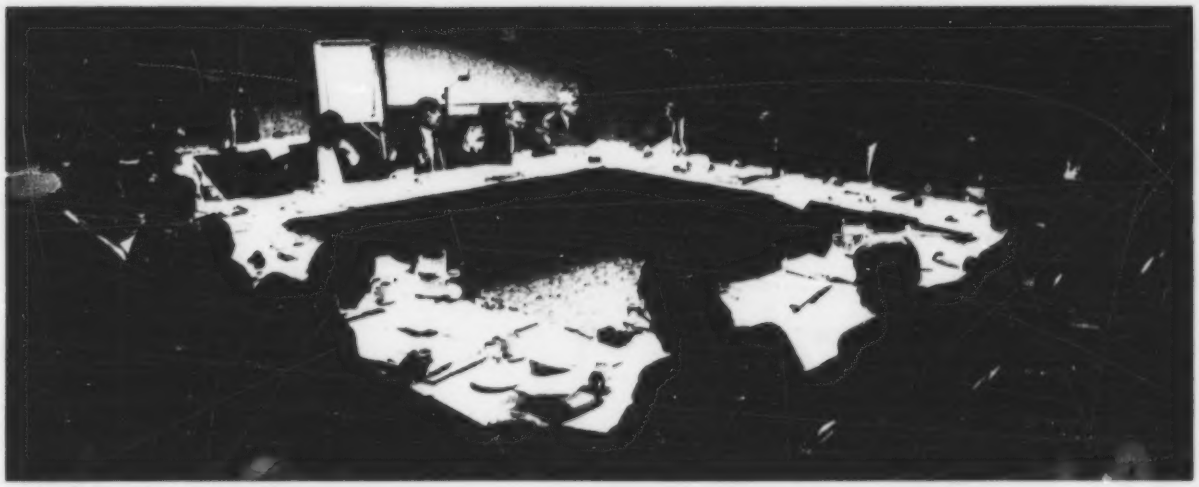
Use and development of district resources are set out in a management plan prepared by the district board in consultation with local people. The plan receives formal review and endorsement by the province before it is adopted by the district board. Management plans are usually re-evaluated with the help of public input every 5 years to make sure they continue to meet district needs.

Local People in Driver's Seat

The districts are welcomed because they put decision-making in the hands of local people. They are seen as an ideal local mechanism to address land and water management while complementing the work of planning districts and other local groups. They provide opportunities for involvement in conservation activities that people everywhere are demanding. They have also earned praise as good business ventures.

The Conservation Districts Authority, of Manitoba Rural Development, was organized to assist conservation districts. It provides planning and advice, administers the provincial grants to the districts, coordinates the engineering assistance and feasibility studies that districts need, and helps new districts with their administrative duties.

Whitemud Conservation District Board and staff. The Board recently prepared a management plan for the district with the help of input from residents.



Manitoba Round Table in session

Manitoba Round Table on Environment and Economy

Canada's initial response to release of the Brundtland Report in 1987 was the establishment of the National Task Force on the Environment and Economy. The Task Force, drawn from business, government, academic circles, and leading environmental organizations, issued its report in September 1987.

Acting on a recommendation in the report, the province established the Manitoba Round Table on Environment and Economy in October 1988.

The Manitoba Round Table comprises government ministers, industry top executives, and leaders from the labour movement, environmental organizations, and academic institutions.

Forum for Finding Common Ground

It serves as a forum in which decision-makers can meet to discuss environment-economy issues and build a consensus on measures to deal with environment-economy trade-offs. It makes recommendations directly to the premier.

The Manitoba government considers that the Round Table is an appropriate forum to ensure that those stakeholders affected by management and development decisions are part of the process.

Each province and territory has its own round table, reflecting its unique environmental and economic make-up. A national round table, drawing most of its membership from the provincial and territorial round tables, brings issues and ideas to the national agenda and provides a national perspective on regional issues.

Translating the Vision

The Round Table's vision for Manitoba is "a sound environment and sustainable economic growth." A sound environment refers to "clean, safe, and healthy air, land, and water in which to live, work, and play." Sustainable economic growth refers to "quality growth that creates ongoing wealth and provides goods and services for present and future generations of Manitobans in an environmentally sustainable manner."

To translate this vision into a sustainable development strategy, the Round Table and Manitoba government are following a process that consists of:

- preparing a series of documents containing draft policies
- holding extensive public consultation on the policies
- adjusting the policies in response to public comment and reporting back to the public
- finalizing the policies and preparing implementation plans.

Beliefs

The Round Table's conviction that sustainable development is critical to our common future stems from the following beliefs:

- We cannot continue to develop economically unless we protect the environment.
- Continued economic development will be needed to pay for important environmental programs.
- The needs of the present must be met without sacrificing the ability of future generations to meet their own needs.
- We must concern ourselves with the long-term effects of environmental and economic decisions.

Cabinet Committee on Sustainable Development

To complement the work of the Round Table, the province set up a Cabinet committee responsible for all matters pertaining to sustainable development. This is the first such Cabinet committee in Canada and is in keeping with the Brundtland Report's recommendation to change the basic structures of government to achieve better coordination of economic and environmental decision-making.

Special Conservation Fund

This fund is a provincial program to promote sustainable development at the community level. It has access to $500,000 generated from Manitoba lotteries revenue.

It finances conservation projects that local groups and organizations support and need in their communities, that sustain and enhance resource productivity, and that improve the quality of life of all Manitobans.

Projects must promote the principles of sustainable development at the local level, and emphasize:

- local involvement and participation
- innovation and imagination
- environmental soundness
- public visibility
- positive impact on the community.

Typical projects include:

- conserving wetlands
- planting trees and enhancing woodlands
- restoring fish and wildlife habitat
- enhancing the ability of local people to manage local natural resources
- preserving rare, threatened, and endangered species and their habitats
- building small-scale water conservation works
- cleaning up parks and other public recreation facilities
- supporting waste reduction and recycling
- running urban conservation and education programs.

Funding is limited to $25,000 per project, per organization, per year. To encourage continued community involvement, funds cover only direct spending on projects, not administrative costs.

Trends

Conservation districts in planning stage ——— Better
Proposals are now under consideration for three new conservation districts in various areas of the province. If the proposals are approved, this would bring the total number of districts in Manitoba to nine.

New sustainable development centre ——— Better
In 1990, Winnipeg was chosen as the site of the International Institute for Sustainable Development. Besides underlining Canada's commitment to the concept of sustainable development, presence of the centre is expected to add impetus to Manitoba's own sustainable development efforts.

Sustainable development strategy ——— Better
An overall sustainable development strategy has been released for public review. Action has also been initiated on 12 component strategies. Water and soil policies have been approved by the province.

Sustainable development policies ——— Better
Draft principles and guidelines have been prepared on a sustainable development strategy for the province, with an exhaustive public consultation process planned to ensure participation of all Manitobans.

In 1990, through matching donations from the Special Conservation Fund Manitobans could "buy an acre of prairie" for only $50 through the Manitoba Naturalists Society's Prairie Patron Program which helps protect our tall-grass prairie.

FOCUS ISSUE: WASTE MANAGEMENT

Waste management has become one of the most pressing problems throughout the world. Our ability to generate wastes has gradually increased to the point where in 1989, Canadians produced more garbage per person than any other nation on earth. We set a world record of 1.7 kilograms per person per day, followed by Australia and the United States which tied for second place at 1.6 kilograms per person per day.

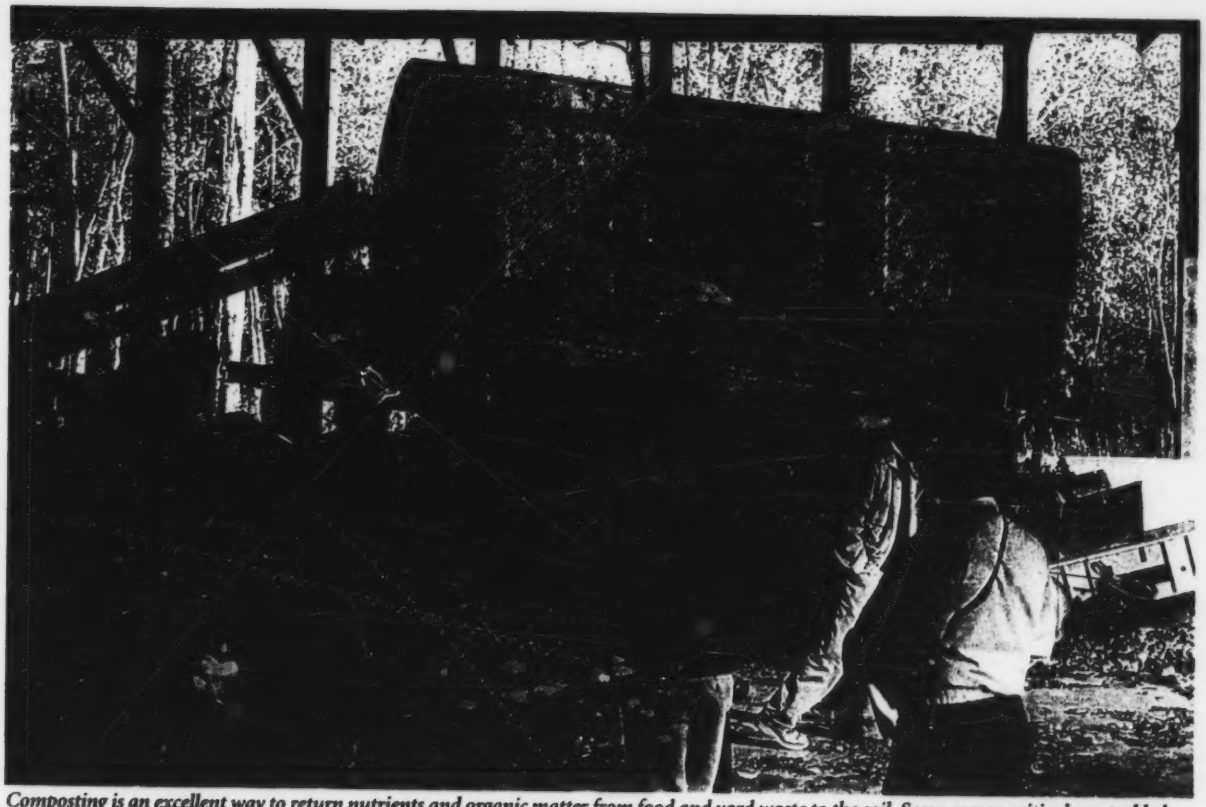
The environment has a finite capacity to absorb waste and we appear to be approaching that capacity in North America. Many of the continent's largest cities are running out of space to deposit municipal wastes. Hazardous waste poses a special problem: we are generating it faster than we can treat it.

The impact of wastes on the environment is not the only problem. Harmful substances that are not disposed of properly can affect human health, directly or through the food chain. Consumers may face economic hardships as costs rise because of the expense of waste disposal. During the 80s, as these problems became more widely known, the public and governments began taking on the challenge of addressing them. The resulting initiatives and activities in Manitoba are highlighted in this section.

Recycling and Waste Reduction

In Manitoba, rag-and-bone men were a regular part of the province's economy in the first half of the century. They went from street to street with horse and cart buying and selling old clothes and furniture. During World War II, Winnipeg's Patriotic Salvage Corps earned the city the distinction of having the highest salvage rate in the nation. But the post-war period has seen us evolve into a consumer, throw-away society that generates more than 1,000,000 tonnes of garbage every year.

Manitobans generate nearly 1,000,000 tonnes of garbage every year – about one tonne of waste for every person in the province.



Composting is an excellent way to return nutrients and organic matter from food and yard waste to the soil. Some communities have tackled composting on a large scale.

The amount of garbage handled by the city of Winnipeg gives an indication of changes in our consumption habits. The quantity grew from 300,000 tonnes in 1970 to 600,000 tonnes in 1987, while the city's population increased by only 17%. Handling and disposing of garbage cost almost $20 million in 1987.

The 4 Rs

The 4 Rs of waste reduction are as follows:

REDUCE: use durable products, maintain equipment and goods, and switch to thinner, lighter materials where possible

REUSE: use refillable containers with a return deposit, and non-disposable products such as diapers, sheets, towels, and dishware

RECYCLE: reclaim potential wastes before they are discarded and use them to make the same or another product

RECOVER: try composting to recover nutrients from food and yard wastes, or recover energy by burning waste materials.

Efforts by the province to put the 4 Rs into action include photocopying reports on both sides of the paper, sending interdepartmental mail in envelopes that can be reused 66 times before being discarded, and collecting aluminum cans and office paper for recycling in many government buildings. Employees at Manitoba Environment compost food waste.

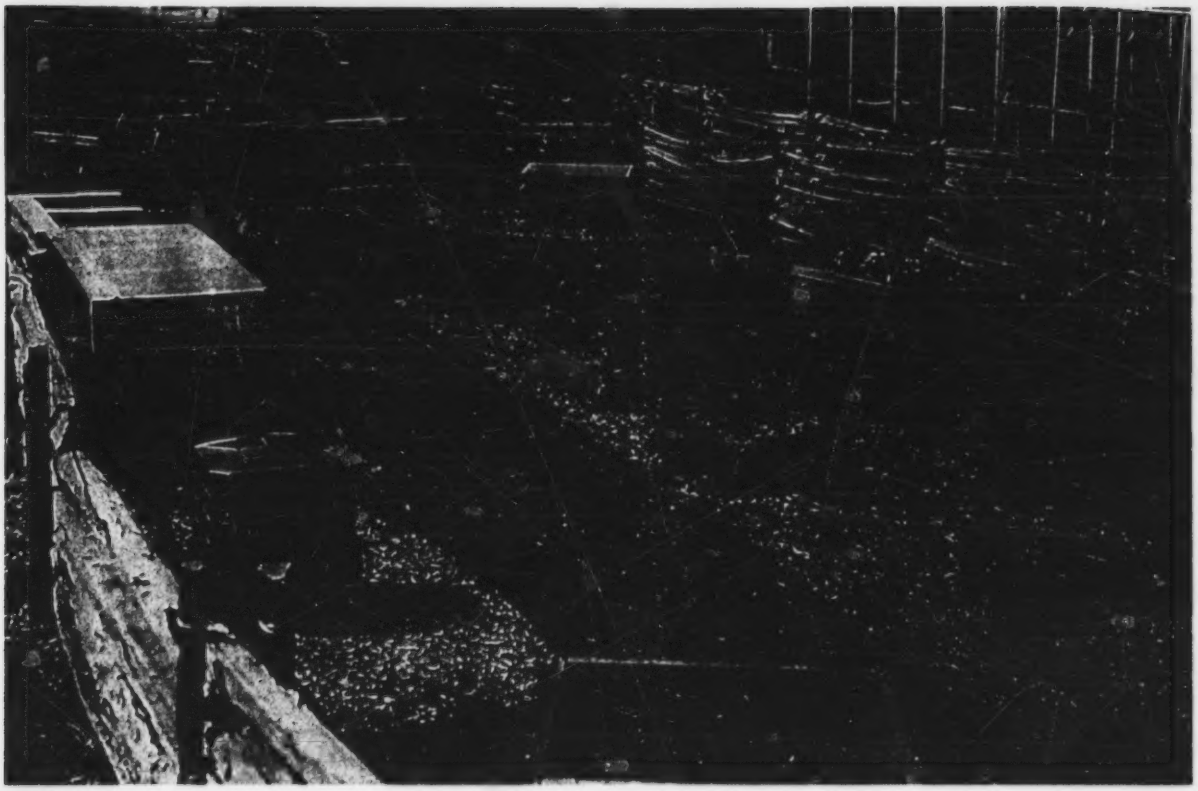
Recycling Initiatives

The Minister of Environment has made a commitment to upgrade waste disposal regulations for Manitoba and to cut by 50% the amount of solid waste we produce by the year 2000. The Waste Reduction and Prevention Act (WRAP Act), proclaimed in August 1990, established a regulatory base and a framework for action to meet the commitment.

Waste reduction is addressed on several fronts. The Recycling Action Committee, a provincially appointed group with 14 members from industry, environmental and consumer groups, and Manitoba Environment was organized to develop recycling strategies for the province. In May 1990, the Committee published an action plan for a waste minimization strategy for the 90s, designed to achieve the 50% reduction goal.

As part of the Waste Minimization Strategy, Manitoba Environment, working with Manitoba Education and Training and interested organizations, has developed materials and activities to be integrated into existing K-12 curricula. The program in the schools will be complemented by purchasing recycled materials, reviewing school cafeteria policies, and separating school wastes for recycling.

The Environmental Innovations Fund was set up to promote new environmental programs, public awareness, and community involvement.



Almost everyone with a backyard can use one of the many available designs of composting bins.

Waste Minimization Strategy

This strategy in response to public demand for more and better information on ways and means of minimizing waste. The strategy also promotes recycling, which has a strong public appeal because it is something everyone can do.

The basic idea is for the province to minimize the amount of waste it produces, and to ensure that the rest of us accept our own responsibilities for cutting waste. The overall goal is a 50% reduction of waste per capita going to landfill sites by the year 2000, compared to the amount in 1988.

"Waste minimization" was chosen as a label for the strategy, rather than "recycling." Waste minimization carries the connotation of reduction and reuse which are preferable to recycling. The strategy recommends that, wherever practical, the 4 Rs should be implemented in order of reduction, reuse, recycle, and recover.

Activities planned under the strategy include:

- a province-wide community outreach program with materials, speakers, and a quarterly newsletter on wast minimization and recycling
- toll-free hot line with consumer information on recycling opportunities
- new resource centre for ready access to information
- anti-litter campaign.

Under the strategy, several materials have been earmarked for waste reduction, including used motor oils and storage batteries, car tires, newspaper, corrugated cardboard, beverage containers, and disposable diapers.

Meeting the strategy's goal of a 50% reduction in waste will take specialized technical skills and ideas in decision-making that could be communicated through in-service sessions for municipal and industrial employees, community college programs, and university level courses.

An interdepartmental committee, formed to examine government purchasing, has started several pilot projects to develop our knowledge and expertise in waste reduction. The committee recently launched a "Paper Rescue" project to collect waste paper from government buildings for recycling.

Waste Paper

More than 25,000 tonnes of waste paper - about 10% of the total - are currently being recovered for recycling in Manitoba every year. Some 12,000 tonnes are old corrugated containers, 10,000 are old newspapers, and 3,600 are office-grade papers.

Scrap Metal Industry

Every year, Manitoba's scrap metal industry processes between 200,000 and 300,000 tonnes of material that would otherwise be wasted. Reusing scrap metal provides employment for more than 1,000 people and spares the environment and our resource base the burden of additional mining.

Metal enjoys an advantage over most wastes because it retains its economic value, making recycling viable. This is not the case for much of the remaining 1,000,000 tonnes of waste that Manitobans generate each year.

Beverage Containers

Manitoba currently operates several systems to redeem some of the 470 million beverage containers sold annually in the province. A system of deposits on domestic beer and refillable soft drink bottles encourages recovery of up to 98% of beer bottles but only 50% of beer cans. Deposit containers are redeemed at point of sale. An agreement in 1986 with the soft drink industry established a voluntary "buy-back" program for soft drink containers. The system has since expanded to include liquor containers, bottled water, and juice products.

Container Returns as Percent of Sales in Manitoba

	1988	1989	1990
Beer bottles	98	99	98
Beer cans	48	50	53
Aluminum cans	24	36	?
Plastic bottles	4	15	?
Liquor containers	0	5	8 (6 months)

?=data not yet available. *Source: Manitoba Environment*

Waste Oil

An estimated 33 million litres of lubricating oil were sold in Manitoba in 1986, with 20% bought by do-it-yourselfers and rural/farm people, a difficult market from which to collect the oil for recycling or other reuses. The current recovery rate province-wide is estimated at 20%, with a potential of 45%, or 15 million litres.

Tires

Each year, about 1,000,000 tires are discarded in Manitoba. In 1990, 13% were thought to have been recycled, 6% were stockpiled at relatively small sites, and 81% went to landfills.

Hazardous Waste

Hazardous waste refers to substances and materials that pose a threat to human health or the environment. They range from common household items to industrial toxics and the biological by-products of hospitals and labs.

Jurisdictions

Hazardous waste management has been mainly a provincial concern, possibly because most hazardous waste legislation now in place in the country has been passed by the provinces. Radioactive waste is an exception, it is under federal jurisdiction in Canada. Interprovincial and international issues are addressed at the federal level under the Canadian Environmental Protection Act and the Transportation of Dangerous Goods Act.

Municipal organizations are not directly involved in regulating hazardous waste generation and movement. However, they can play a critical role in protecting the environment by designating routes for transporting dangerous goods, and by regulating access to sewer systems and landfills.

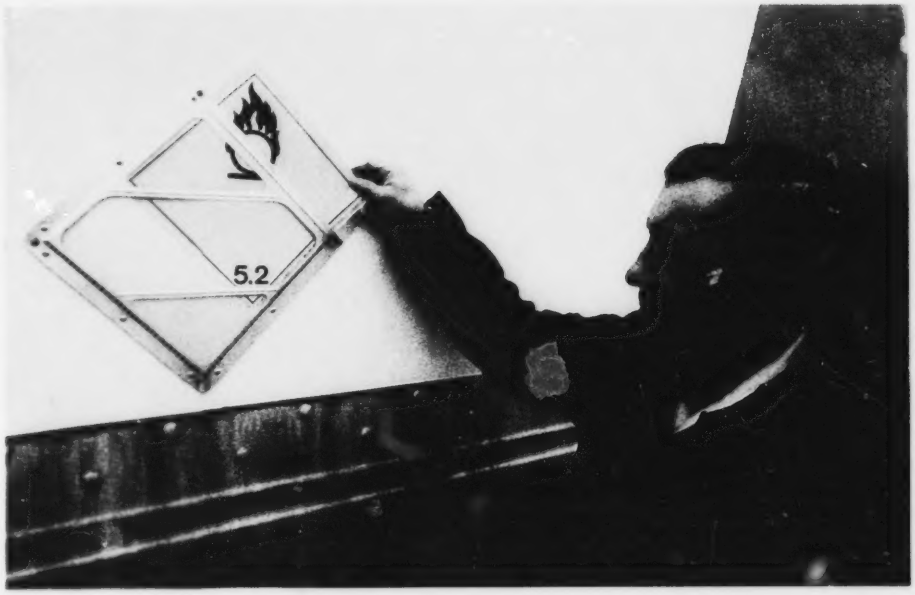
The city of Winnipeg, for example, recently passed a by-law controlling the types of wastes that can be discharged to the city's sewer system.

Recognizing the need for in-province capability to treat hazardous waste, the province established the Manitoba Hazardous Waste Management Corporation in 1986.

Classifications of Hazardous Waste

Classification	Sub-Group	Example
1. Explosives		Dynamite
2. Compressed gases	Flammable	Propane
	Poisonous	Sulphur dioxide
	Corrosive	Chlorine
	Non-flammable, non-corrosive, non-poisonous	Oxygen
3. Flammable liquid		Gasoline
4. Flammable solid	Flammable	Phosphorus
	Spontaneously combustible	Activated carbon
	Flammable on contact with water	Calcium carbide
5. Oxidizers	Oxidizers	Nitrate
	Fertilizer	
	Organic peroxides	
6. Poisonous	Poisonous	Pesticide residue
	Infectious	Hospital waste
7. Radioactive		Spent reactor fuel
8. Corrosive		Sulphuric acid
9. Miscellaneous	Miscellaneous	PCBs
	Environmental hazard	Pesticides
	Dangerous waste	Wastewater Sludge

A placard specifies what dangerous goods are carried in the truck. Shipments of hazardous waste must also be accompanied by a manifest to ensure that the cargo can be tracked from origin to destination.



C.N. train derailment at Elma, Manitoba, November 1989. Manitoba Environment's Emergency Response Team was called in to supervise salvage operations because the tankers carried butadiene, a flammable gas.

Transportation

Hazardous waste often needs to be transported from sites where it was produced to sites where it can be stored, treated, and disposed of properly. While in transit, it is subject to the same regulations as all dangerous goods.

In 1989, Manitoba Environment received manifests for more than 600 shipments of hazardous waste in the province. The number of shipments is expected to increase significantly as provincial hazardous waste legislation is enforced more rigorously.

Many people believe that shipments of hazardous waste pose a greater risk to the environment and public safety than shipments of other dangerous materials. There is no evidence to support this belief. In fact, the more stringent standards that apply to the transportation of hazardous waste reduce the risk.

Another common misconception is that accidents involving dangerous goods or hazardous waste happen mainly during transportation. Records show that other causes are just as frequent.

Incidents Involving Contaminants – June 1988 to June 1989

Incident type		Materials involved	
Transportation	69	Gasoline or diesel fuel	78
Handling	69	Other dangerous goods	104
Equipment failure	65	Other materials	78
Other causes	57		
Total Incidents	**260**		**260**

Source: Records of the Emergency Response Team, Manitoba Environment. The total number of calls received through the emergency response system during the period was 447.

Disposal

Disposing of hazardous waste may involve changing the composition of the waste to a less hazardous form by burning or chemically neutralizing it. Another measure is to prevent the waste from coming into direct contact with the environment. Acids are often neutralized, solvents are incinerated, and heavy metals are stabilized in an insoluble, concrete-like substance called pozzolanic cement.

Recycling and reduction are preferable to disposal. Waste solvents, for example, can often be distilled to remove impurities. According to 1989 statistics, however, less than 1% of the hazardous waste generated in Manitoba is being recycled. The Manitoba Waste Exchange keeps records of wastes available to those who may have further use for it; for example, caustic waste may be used to neutralize acids or acidic waste, presenting a cost effective and environmentally friendly alternative to straight disposal.

Until treatment facilities become available, places that generate hazardous waste must ship the waste out of the province at relatively high cost. Unfortunately, a significant proportion of hazardous waste finds its way into sewers and landfills.

Statistics from 1989 show that 178,000 tonnes of hazardous waste are generated in Manitoba each year. Most of this waste can be treated where it was generated.

About 22,600 tonnes requires treatment or disposal offsite. Yet in 1989, only 2,345 tonnes of hazardous waste, 70% of it old car batteries, were shipped out of province for treatment.

Contaminated Sites

Contaminated sites are locations where soil or groundwater has been polluted by the dumping of hazardous materials. The major concern is that material from the site can migrate to groundwater or pollute neighbouring properties through local drainage channels.

The most widely publicized contaminated sites in Manitoba include:

- the former Domtar plant in Transcona, which is contaminated by wood preservatives
- parts of the village of Birds Hill where gasoline has contaminated the groundwater
- the area around the Portage la Prairie waste disposal ground where arsenic has contaminated groundwater.

In 1975, the Clean Environment Commission reported that 33 Manitoba communities were experiencing some degree of water contamination from petroleum leaks or spills.

The extent of damage at a contaminated site is often not discovered until years later. By then clean-up may be impossible and the cost of remedial action far beyond the financial capability of the property owner. In some cases, the responsible party cannot be identified. Government departments may have to fund the clean-up – a situation which the United States had to address through their $5 billion Superfund.

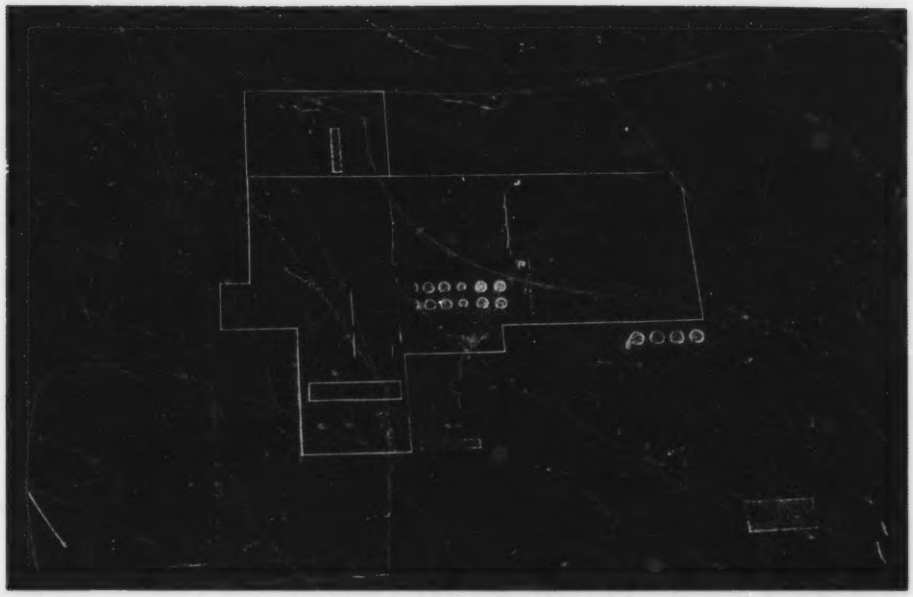
The Canadian Council of Ministers of the Environment has established a contingency fund to cover the cost of cleaning up such "orphan" sites.

Steam-cleaning at the Domtar Wood Preservative Site. When the Domtar site was closed in 1975, officials from Manitoba Environment found soils at the 62-hectare site contaminated by creosote, penta-chlorophenol, dioxin, and furans – toxic compounds that had been used as wood preservatives. Site rehabilitation, in progress since 1985, includes draining and filling in surface ponds, sealing all wells, removing contaminated wood chips, and steam-cleaning concrete structures and soil.

Managing Hazardous Waste –A System for Manitoba

In 1982, the province launched a program to develop a comprehensive hazardous waste management system for Manitoba.

Effort focused initially on developing public awareness of the need for a system, as well as on preliminary technical studies of types of hazardous waste generated in the province, disposal facilities that might be needed, and options for managing hazardous waste.



Architectural model of proposed central plant for treating hazardous wastes

More Than Regulations

Results of studies and public input made it clear that it would take more than regulations to make any hazardous waste management system work. This led to the formation of the Manitoba Hazardous Waste Management Corporation, a commercial Crown corporation with a mandate to set up and operate a system that would "safely treat and dispose of hazardous waste in accordance with regulations and standards prescribed by the Minister of Environment."

Since becoming operational in August 1987, the corporation has established small licensed collection and storage facilities at Gimli and Winnipeg. It currently provides a range of public and commercial waste management services.

Terms of Reference

Most of the corporation's activities involve planning and developing a hazardous waste management system for the province. Under the corporation's terms of reference, the system must:

- manage hazardous waste in ways that protect human health and safety and environmental quality
- handle all provincially regulated hazardous waste
- open for business as soon as possible so that hazardous waste producers can comply with current regulations
- offer a full spectrum of waste management options
- stress management of waste at its source through reuse, recycling, recovery, and reduction
- remain affordable to users yet discourage the generation of waste
- offer the same service at the same charge regardless of where the waste is generated in the province or the amount of waste generated
- operate at minimum cost to the taxpayer
- involve public input and acceptance.

The system would also include facilities for analysing, collecting, transporting, storing, consolidating, and treating hazardous waste that required off-site management.

The corporation estimates that the system will need to cope with 180,000 tonnes of waste each year. Over 85% of this volume will eventually be managed at source. Of the remaining 23,000 tonnes of material, 9,000 tonnes are organic waste and 14,000 tonnes are inorganic waste. Organic waste will be recycled or exported to facilities outside Manitoba. The rest will be treated within the province.

Facilities Required

Two major facilities will be required somewhere in the province, a storage and transfer facility and a central treatment plant. Candidate sites would have to offer a high degree of environmental protection and be accepted by the local community.

Since early 1989, when the site selection process began, more than 50 municipal councils have expressed interest in the development. The corporation has investigated prospective sites in several rural municipalities and local government districts, as well as in Winnipeg.

Site evaluation, facility design, and environmental impact assessment work needed to make a final application to Manitoba Environment is expected to be complete by the spring of 1991. Operation of the facilities could begin as early as 1992.

Phasing Out PCBs

Polychlorinated biphenyls (PCBs) are synthetic liquid chemical compounds of chlorine, carbon, and hydrogen that were imported to Canada between 1929 and 1977. They are still used because of their fire-resistant, insulating, and chemically stable properties.

Of the 40,000 tonnes of PCBs imported to Canada, an estimated 13,000 tonnes have entered the environment as components of such materials as inks, lubricants, and waxes as well as through direct spills and dumping. In Manitoba, the known quantity in use or storage is 4,050 tonnes.

PCBs in high concentrations can cause birth defects, cancer, liver damage, and nerve disorders. Fires in electrical equipment with PCBs can produce dioxins and furans – among the most toxic substances on earth.

Episodes in recent years have a direct bearing on renewed government attention to the management of PCBs. In 1985, about 400 litres of 56% PCB transformer oil leaked from a truck along a 100-kilometre stretch of the Trans-Canada Highway between Ignace and Kenora. The accident required clean-up and re-capping of 15 spill areas as well as extensive decontamination of vehicles.

On August 24, 1988, 3,000 people in St. Basile-le-Grand, Quebec, were forced from their homes by a toxic chemical cloud produced when a warehouse containing illegally stored PCBs burst into flames.

Governments are tightening regulations, with a goal, adopted by the Canadian Council of Ministers of the Environment, to phase out all PCBs by 1993. They have developed strategies for monitoring, storing, and disposing of PCBs. Since Canada has few facilities for disposing of PCBs, the current priority is secure storage, while new technologies for destroying PCBs are under development.

In Manitoba, PCBs are being steadily phased out. Manitoba Hydro leads the field in the chemical treatment of oils containing PCBs at concentrations of less than 2,000 parts per million. By June 1990, Hydro had cleaned over 6 million litres of oil contaminated by PCBs. All PCB storage sites are licensed and inspected.

Secure storage for PCBs at Manitoba Hydro

The Manitoba Hazardous Waste Management Corporation is currently addressing the problems of storing and treating PCBs as part of its mandate to develop a comprehensive hazardous waste management system for the province. The corporation will eventually manage PCBs to final destruction.

The careful on-site storage of PCB material in small containers is both safe and practical. For example, fluorescent light ballasts, now being phased out because they contain PCBs, can be stored at minimum risk pending development of handling services.

Reported PCB Materials in Manitoba (tonnes)

	In use	Stored
Manitoba Hydro	2,600	410
Winnipeg Hydro	136	42
Industry	588	200
Miscellaneous		279
TOTAL	**3,324**	**931**

Source: Environment Canada,Manitoba Environment

Biomedical Waste

Health care establishments commonly generate hazardous wastes such as used drugs, solvents, tissues and infectious materials, and used "sharps" – needles and scalpel blades. Some hospital waste includes low level radioactive materials.

Use of disposable syringes, needles, and similar materials contributes to the general wastefulness of modern society and to the consumptive use of resources; yet it is convenient and prevents the spread of infection. The treatment of biomedical waste is being addressed in cooperation with other provinces and the federal government.

Waste Oil and Solvents

An estimated 1,000 tonnes of waste solvent and 7,000 tonnes of waste oil are generated each year in Manitoba. Sources range from industrial processes to the small amounts generated in the home.

Waste oil and solvents represent a major problem of hazardous waste management because they often get mixed together before disposal. If the solvents are chlorinated, they render the oil unsuitable for use as a supplementary fuel.

A few industries recycle their solvents, but most use commercial disposal firms to get rid of them. Some industries dump them illegally, in sewers or at local landfills.

Disposing of waste oil is often a problem for rural residents. Other than using it to keep dust down on gravel roads – an environmentally unwise practice currently under review – residents dump most of their waste oil at local disposal grounds.

In Winnipeg and surrounding areas, waste oil is collected by local firms and shipped for recycling or for use as fuel in asphalt plants.

Manitoba Environment is currently examining options for managing waste oil, ranging from re-refining to burning in incinerators or cement kilns. The Manitoba Hazardous Waste Management Corporation plans to make the collection of waste oil part of its overall system.

Pesticide Containers

In 1990, Manitoba farmers bought more than 800,000 containers of pesticides. Pesticides are toxic and some resist decomposition. They can enter nearby waters and find their way into the aquatic food chain.

Although farmers have relied increasingly on chemicals since World War II, the province has only recently come to grips with the problem of how to dispose of the used containers and their poisonous residues.

The situation is improving. Manufacturers, distributors, users, and regulators are lending a hand by standardizing containers, packaging chemicals in crystalline form, and recycling, rinsing, and separating containers from other garbage.

The Crop Protection Institute of Canada and the Association for a Clean Rural Environment are expected to play key roles in solving the problem, which includes eliminating existing "dumps."

In 1982, Manitoba Environment and Manitoba Agriculture began a container clean-up project in cooperation with the municipalities. Pesticide residues were drained from containers at designated municipal collection sites and taken away for safe disposal. Metal con-tainers were crushed and recycled in steel mills. Plastic con-tainers were shredded and buried.

The ratio of plastic containers to cans has risen significantly over the years, creating an additional problem. Containers are often burned in open fires, since there are no regulations to the contrary. To date, the only alternatives are to burn the containers in high-temperature incinerators – a costly process – or clean them and deposit them in a landfill, preferably after shredding to reduce volume. Although, technically, plastics can be recycled, plastic pesticide containers are seldom recycled because of the potential for contamination by pesticide residues. The range of products that can be safely manufactured from recycled containers is limited. Prairie Environmental Services, a private firm working with the technical assistance of the Manitoba Hazardous Waste Management Corporation, received approval to establish a facility for decontaminating pesticide containers and eventually recycling the rigid plastics for use in building materials.

Some types of empty chemical containers are considered hazardous waste. Manitoba Environment has developed an operating order for all collection depots to ensure that hazardous waste is handled safely.

In 1989, a fenced compound in the R.M. of Rossburn measuring 15 metres by 7.5 metres was cleared of 3,500 containers. The cleanup was part of an experiment to find ways of cleaning up some of the 150 designated collection sites in the province. The containers were drained, then pressure-rinsed. Metal containers were crushed and plastic containers shredded. Residue and rinsate were transferred to safe storage, the metal to recycling facilities, and the plastic to a landfill.

The cleanup yielded 620 litres of residue, 2,050 litres of rinsate, 3 tonnes of metal, 1 tonne of shredded plastic, and 1 tonne of cardboard. Only half the plastic containers, and a handful of metal containers, had been properly rinsed before being dumped.

In 1989, a $1.00 charge was added to the cost of every pesticide container to help cover clean-up and disposal. The money is collected by the Crop Protection Institute of Canada and administered by the Association for a Clean Rural Environment, a provincially appointed board with a mandate to help clean up accumulations of pesticide containers by finding methods, allocating funds, and monitoring performance.

Cleaning up pesticide containers at Rossburn. Accumulated pesticide from unrinsed "empty" containers poses a special environmental problem.

Pesticide Container Cleanup 1985 to 1988

	1985	1986	1987	1988
Locations*	23	30	38	22
Residue collected (L)	14,350	14,183	13,200	7,585
Cans crushed	170,800	162,346	127,000	70,673
Plastic pails destroyed	–	168,550	169,000	119,760

**Only those reported to Manitoba Environment are included; the actual numbers were higher.*

Source: Manitoba Environment

Household Hazardous Wastes

Leftover paint thinners, cleansers, pesticides, bleaches, and furniture polishes are examples of household hazardous waste. Because they may explode, be poisonous, ignite easily, corrode other materials, or react strongly with water and other substances, they present a problem when it is time to discard them.

Small dry batteries, a seemingly unimportant type of hazardous waste, account for about 35% of the total amount of mercury released into Canada's environment.

Although household hazardous waste may not add up to much in the home, it presents a range of hazards when collected. The total amount from a community or city may be a significant source of groundwater pollution. At refuse sites, workers can suffer injuries when dangerous materials are released from residential pickups. Collection vehicles have been destroyed by fires started by the mixing of household hazardous wastes. People can be injured and property damaged by spills of refuse cans containing hazardous waste.

From 1986 through 1989, Manitoba Environment operated a once-a-year depot near the provincial office in Winnipeg for the safe disposal of household hazardous wastes. Over a 3-day period during National Environment Week, people were encouraged to drop off hazardous waste from their homes. The city of Winnipeg, Environment Canada, and the Biomass Energy Institute provided financial and staff support.

Waste oil and batteries brought in were recycled. Other types of waste were sent for disposal to facilities outside the province.

During operation of the depot in 1989, a "paint swap" was arranged to give participants an opportunity to take away paint in good condition.

In 1989, the Manitoba Hazardous Waste Management Corporation set up a year-round depot in Winnipeg for dropping off household hazardous wastes. The corporation also conducted 25 household hazardous waste days in smaller communities, collecting about 7 tonnes of various materials.

Household Hazardous Waste Collected in Winnipeg

	1986	1987	1988	1989
Solid (kg)	396	254	2,880	2,680
Liquid (L)	4,847	2,470	2,375	6,210

Source: Manitoba Environment

Manitoba Hazardous Waste Management Corporation's hazardous waste depot at 745 Logan Avenue in Winnipeg. During the first half-year of its operation, more than 20 tonnes of material were collected, with some 750 householders visiting the depot.

Municipal Solid Waste

The average person in Manitoba generates nearly a tonne of garbage every year. Collection and disposal is traditionally a municipal responsibility, with the province involved in a regulatory role.

An estimated 40,000 tonnes or more of waste can be placed into each hectare of landfill space. If this amount of waste were placed in all of Manitoba's landfills, only about 25 hectares of land would have been needed for waste disposal in 1987. Between 1990 and the year 2000, an estimated 445 hectares of additional land will be needed for waste disposal - about three times the size of Assiniboine Park.

Waste disposal grounds are controlled by a regulation now under revision to correct a range of problems, including improper siting of waste disposal grounds, open burning, and improper site closures.

Siting of Waste Disposal Grounds

The availability of a piece of property, rather than its suitability, has traditionally been the main criterion for siting disposal grounds, particularly those serving smaller population centres.

Facilities have been developed in less than satisfactory locations through lack of attention to soil permeability, suitability of soil for use as cover material, or potential for pollution of groundwater and surface water supplies.

These factors, as well as site accessibility, type of vegetation, service and access roads, dust, noise, odour, and the effects of methane gas buildup must be thoroughly examined when locating new landfill sites.

A landfill identification and assessment program was completed by Manitoba Environment in 1986. Several problem sites were identified, with remedial action pending the availability of sufficient funds.

Under the revised Waste Disposal Grounds Regulation, prospective Class 1 sites must be described in detailed proposals filed under The Environment Act and may require public hearings. All sites must be approved before construction, and may require investigation by a registered engineer. Operational requirements are set out in site-specific, strictly enforced licences.

Consolidation of Sites

An effective way to reduce the overall environmental impact of waste disposal is to close several smaller sites and establish a central regional disposal facility.

Although the province lacks regional disposal facilities for either hazardous waste or conventional municipal waste, some disposal grounds are shared successfully by different jurisdictions. For regional disposal facilities to become a reality, partnerships need to develop between local jurisdictions and government incentives such as grants or interest-free loans might be needed.

Burning

Open burning is one of the most common causes of complaints from residents living near waste disposal sites.

Many municipalities take the position that burning is justified because it reduces the volume of garbage and discourages rats and other potential carriers of disease by destroying food.

Despite the findings of technical studies that overwhelmingly reject this position, and policies that prohibit open burning in most jurisdictions, the practice is still popular, especially at smaller sites in Manitoba. Revisions to the Waste Disposal Grounds Regulation will prohibit open burning at most sites.

Composting

Composting is becoming popular among householders, rural and urban, and even communities are getting involved on a larger scale. Residents of Winkler started a composting project for their community, complete with collection from households. A similar project is under way in Virden.

Energy from Waste

Incineration can be a viable option if quantities of waste and restrictions on landfill sites warrant it.

The best option for incineration is usually known as an "energy from waste" plant where municipal waste is burned to produce energy for associated operations. Although incinerators can operate within environmentally acceptable levels, they are often difficult to site because of public concerns about air emissions, accidents, and ash disposal. Currently, there are no such plants operating in Manitoba.

However, on-site incinerators have been constructed in Manitoba for disposing of waste and in some cases recovering energy. They are found in schools, health care facilities, and wood-related industries (*see* **Air**).

Site Closures

When a waste disposal site is filled to capacity and the site is ready for closure, current regulations require only that all exposed waste be covered with a layer of compacted earth and that the area be graded to minimize ponding.

Other than a policy of not allowing construction of buildings on top of old sites, there are no provincial requirements covering the end use of the land, and no time limit for closing the site.

In the last decade, eight major waste disposal grounds and less than ten minor sites were closed in the province. These sites cover roughly 450 hectares. With the exception of one major site in Winnipeg, most were not closed properly. After the initial covering of waste and the grading work, the sites were simply abandoned.

In addition to tougher site closure requirements, the revised Waste Disposal Grounds Regulation will require that proposals for new large landfills (Classes 1 and 2) include an end use plan for the landfill after the site is closed.

Harbour View Recreation Complex. Built on a former landfill site, the complex features a 9-hole golf course, bowling green, and boating area.

Manitoba's Solid Waste[1]
(tonnes)

Food waste	220,000
Paper other than newsprint	206,000
Yard waste	150,000
Newspaper	144,000
Metals	64,000
Plastic, rubber, leather	50,000
Glass	50,000
Miscellaneous	46,000
Cloth	40,000
Wood	30,000
TOTAL	**1,000,000**

1. Estimated; does not include hazardous waste.

Source: Manitoba Environment

Waste Disposal Grounds

	Number	Population served	Percent total
Class 1[1]	13	719,088	66.3
Class 2[2]	78	209,672	19.3
Class 3[3] or none	368	156,540	14.4
TOTAL	**459**	**1,085,300**	**100.0**

1. Class 1 – waste disposal ground serving a population of more than 5,000. 2. Class 2, 1,000 - 5,000. 3. Class 3, less than 1,000. The total excludes disposal sites on land under federal jurisdiction.

Source: Manitoba Environment

Special equipment applying sludge from the Winnipeg sewage treatment plant as fertilizer. Correct timing and monitoring ensures that the application does not pose a health hazard.

Liquid Waste

In addition to the 1 million tonnes of solid waste generated in the province each year, more than 1.5 billion litres of wastewater travel down the drain to various sewage treatment systems. About 95% of Manitobans are served by municipal sewage systems. The rest use private systems, usually a tank and septic field.

Wastewater treatment facilities in the province fall into three categories: wastewater treatment lagoons, aerated lagoons, and sewage treatment plants.

Wastewater treatment lagoons contain a primary cell, where sewage is treated by aerobic bacteria, and a secondary cell where the sewage is further treated before being discharged to a watercourse.

Aerated wastewater lagoons are similar to regular lagoons except that they use bubblers and sprays to speed up bacterial action.

Sewage treatment plants use bacterial action as well as specialized mechanical processes for the most rapid and complete breakdown of raw sewage.

Lagoons are drained into rivers and streams, usually in spring when the receiving water body is free of ice cover and biological processes have resumed.

Organic sludge, a by-product of municipal sewage treatment systems, is either deposited in landfills or applied to land as fertilizer. Since sludge contains pathogens and trace toxic elements, such as heavy metals, as well as nutrients, it has limited application as a fertilizer and must be handled and monitored carefully. Winnipeg, Brandon, and Virden are currently the only communities with sludge fertilizer programs.

Combined Sewers

Until the 1930s, many of the province's towns and cities built combined sewers designed to carry domestic sewage as well as runoff from streets and rooftops. Increasing volumes of runoff and "dirty" water flowed directly into our rivers, damaging the environment and creating difficulties for those living downstream who rely on the rivers for their water supply.

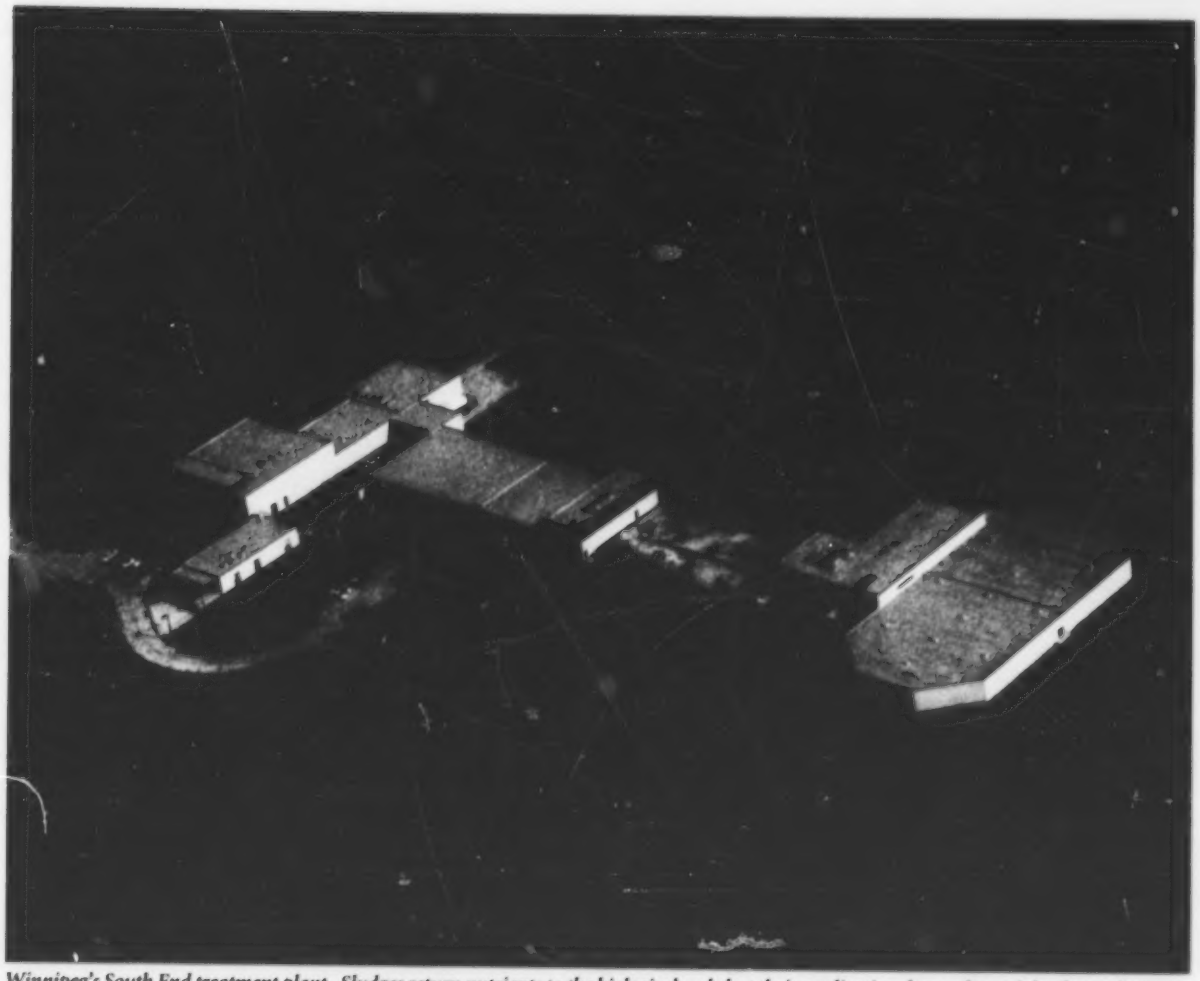
Combined sewers are no longer allowed. In Winnipeg, 98% of wastewater is now treated before it is released to watercourses. The remaining 2% of untreated wastewater originates in overflows from the remaining few combined sewers during heavy rainstorms. Since these old sewers are difficult and costly to upgrade, the situation is likely to remain unchanged for some time.

Wastewater Treatment Facilities*

Type	No.	Licensed under The Environment Act
Wastewater Treatment Lagoons	346	337
Aerated Wastewater Lagoons	12	12
Sewage Treatment Plants	81	81
Total	**439**	**430**

** Excludes facilities on lands under federal jurisdiction.*

Source: Manitoba Environment



Winnipeg's South End treatment plant. Sludges return nutrients to the biological cycle but their application demands special safety techniques and monitoring because of heavy metal content.

Lack of Upgrading

When operated as designed, wastewater treatment facilities work efficiently. The problem is that the communities they serve often outgrow them. Effluent released may fail to meet provincial criteria and pollute receiving streams.

Wastewater is not the only source of extra loading on a sewer system. Groundwater can seep into the sewers through cracks in the pipe and at faulty joints. Runoff from heavy rains can enter the system through manholes in low-lying locations.

The simple expedient of expanding the treatment facility to handle the extra loading from infiltration and community growth does not always work, particularly if the collection system had deteriorated.

Unfortunately, it is often easier to get funding for a highly visible capital project such as a new facility than for a less visible improvement such as renewing sewer lines, with the attendant disruption of residential and commercial areas.

New Industries

Industries that discharge waste into municipal sewers are not normally required to treat their own sewage. This does not present a problem when the municipal system is designed to handle such waste. But when new industries come to smaller centres, they can overload the system.

Dollar Solution

System overloading is a fact of life but it can be dealt with. The challenge is to find the money to implement the technical solutions available.

Responsible planning and public acceptance of the taxation needed to fund the solutions are essential if municipalities are to keep ahead of system overloading.

Private Sewage Systems

People living outside areas served by municipal sewers usually rely on septic systems or holding tanks. In a septic system, sewage is treated in a septic tank, then released as effluent to a disposal field for further treatment by bacteria in the soil.

A holding tank, as the name implies, holds sewage until it can be pumped out and disposed of properly – preferably at a sewage treatment facility.

Both types of systems can cause problems. Effluent from septic fields can contaminate groundwater supplies in areas where the soil under the field is not protected by an impervious layer of clay. In heavy clay soils, if the field is not large enough, effluent may not dissipate but pond on the surface, creating a health hazard.

Sludges from septic tanks, and the contents of holding tanks, are normally hauled away by commercial operators. In some areas their disposal is a problem, because operators use "liquids pits," still found at some municipal landfills, which cannot properly dispose of effluent as in a wastewater treatment lagoon.

Manitoba Environment inspects all private sewage disposal systems at least once every 5 years.

Private Sewage Disposal Systems Installed in 1989[1]

Region	No. of systems	No. typically added/year
Winnipeg	190	200 - 300
Grassland	746	700 - 850
Broadleaf/Mixedwood	868	1,100 - 1,200
Northern Coniferous & Northern Transition/ Tundra	119	110 - 120
Total	**1,923**	

1. Registrations received by the Manitoba Environment in 1989. Systems are occasionally installed without being registered, especially outdoor privies and holding tanks.

Source: Manitoba Environment

Inspecting a private sewage disposal system. All private sewage disposal systems must meet Manitoba Environment standards which are designed to prevent contamination of water and soil.

Public/Government Partnerships

In recent years, the public has had a greater say in environmental management. Various grass roots organizations continue to voice their concerns on environmental issues, encouraging their governments to change old policies and adopt new ones. Non-government organizations are becoming important partners in helping provincial departments develop policies and protect the environment.

Recycling is a case in point. Strong public demand and lobbying by environmental groups has helped convince policy makers to put more manpower and funding into this area.

The Association for a Clean Rural Environment and the Resource Recovery Institute are just two examples; both are active in the waste management field. Other organizations serve as pools of expertise, monitor governmental activities, provide some idea of the public's acceptance of government policies, and back lobbyists who urge a single direction.

The province also strives to benefit from the experiences of other provinces and the federal government. Staff of Manitoba Environment serve on committees associated with the Canadian Council of Ministers of the Environment, the Government Refuse Collection and Disposal Association, the Air and Waste Management Association, and Environment Canada to further define and resolve waste management issues across Canada.

Waste Management Legislation in Manitoba

Here are the main acts and regulations that affect waste management in the province. Efforts are under way to strengthen and improve the legislation by revising outdated regulation and introducing new ones under the provincial acts.

The Environment Act

MR 92/88R	Litter
MR 93/88R	Livestock Production Operations
MR 95/88R	Private Sewage Disposal
MR 98/88R	Waste Disposal Grounds

The Dangerous Goods Handling and Transportation Act

MR 139/99	Manifest
MR 172/85	Handling/Transport
MR 175/87	Generator Registration
MR 282/87	Classification Criteria
MR 439/87	Environmental Accident Reporting
MR 474/88	PCB Storage Sites

The Waste Reduction and Prevention Act

Meeting the Challenge

Waste management is a challenge that demands a concerted effort on several fronts:

- Acts and regulations provide a framework to enforce proper ways of reducing and handling waste.
- Incentives to industry, and incentives and support to recycling, composting, and other "grass roots" movements started by concerned citizens, encourage public involvement and participation.
- Public meetings and open houses, distribution of information, public consultation, and environmental studies in the classroom form a critical educational component.
- Research and development help find ways and means of handling and disposing of wastes.

Not all of these efforts can be pursued with the same vigour, but all are necessary if we are to succeed in dealing with this problem of our own making.

Trends

Capacity to treat hazardous waste ——— **Better**
Facilities are already available outside the province, and plans for a treatment plant are in progress.

Operation of municipal waste landfills ——— **Same**
Little change during the 1980s. There are several problem sites, and waste is still being burned at unsupervised landfills.

Waste management legislation ——— **Better**
The WRAP Act, proclaimed in 1990, and several regulations passed in the late 80s, provide a framework for better waste management in the province.

Per capita waste generation ——— **Worse**
Waste generation doubled in Winnipeg from 1970 to 1987, even though the city's population increased by only 17%.

Recyclable waste being recycled ——— **Better**
Amounts of recycled paper and numbers of redeemed beverage containers are steadily increasing. Efforts by private citizens and government to put the 4 Rs of waste reduction into action are on the increase, ranging from composting to a "Paper Rescue" project.

MANITOBA PLANTS AND ANIMALS

This section lists scientific names and common names (if any) of all higher plants and animals in the province. Scientific names, rather than common names, are cited first for each species because many plants do not have common names, or if they do, their common names may apply to more than one species (e.g., *Gentiana andrewsii* and *Gentiana linearis* have both been called Closed Gentian).

The list is organized under eight major headings, from lichens to mammals. Under most major headings, families are listed in their accepted order, and then under each family, genera and species are listed alphabetically, to make it easier to locate individual species.

If you are not accustomed to reading a list of this type, it may help to focus on common names which are set in bold type down the right-hand side of each column, starting with ferns on page 173.

LICHENS

Acarospora molybdina (Wahlenb. in Ach.) Trev
Alectoria americana Mot.
bicolor (Ehrh.) Nyl.
nidulifera Norrl.
nigricans (Ach.) Nyl.
ochroleuca (Hoffm.) Massal.
sarmentosa (Ach.) Ach.
Anaptychia speciosa (Wulf.) Mass.
kaspica Gyel.
Arctopannelia centrifuga (L.) Ach.
incurva (Pers.) Hale
Arthonia lecideela Nyl.
Aspicilia cinerea (L.) Korber
Bacidia bagliettoana (Massal. & Denot. in Mass.) Jatta
epixanthoides (Nyl.) Lett.
naegelii (Hepp) Zahlbr.
sphaeroides (Dicks.) Zahlbr.
Baeomyces carneus Flk.
Bellemerea alpina (Sommerf.) Clauz. & Roux
Biatora vernalis (L.) Fr.
Bryochaulon divergens (Ach.) Karnefelt
Bryoria chalybeiformis (L.) Brodo & D. Hawksw.
fremontii (Tuck.) Brodo & Hawksw.
furcellata (Fr.) Brodo & D. Hawksw.
fuscescens (Gyelm.) Brodo & Hawksw.
lanestris (Ach.) Brodo & Hawksw.
nitidula (Th. Fr.) Brodo & Hawksw.
simplicior (Vainio) Brodo & Hawksw.
Buellia disciformis (Fr.) Mudd
parasema (Ach.) T.Fries.
punctata (Hoffm.) Mass.
Calicium polyporaeum Nyl.
pusillum (Ach.) Floerke.
trabinellum (Ach.) Ach.
Caloplaca ammiospila (Wahlenb.in Ach.)
elegans (Link) Th. Fr.
holocarpa (Hoffm.) Wade
jungermanniae (Vahl) Th. Fr.
sinapisperma (Laam. & DC.) Maheu & A. Gillet
stillicidiorum (Vahl) Lynge
tetraspora (Nyl.) Oliv.
tiroliensis Zahlbr.
Candelaria concolor (Dicks.) Stein.
fibrosa (Fr.) Mull. Arg.
Candelariella aurella (Hoffm.) Zahlbr.
vitellina (Ehrh.) Mull. Arg.
xanthostigma (Pers.) Lettau
Catapyrenium cinereum (Pers.) Korber
Catillaria arctica Lynge
glauconigrans (Tuck.) Hasse
globulosa (Floerke) T.Fries.
micrococca (Koerb.) Fink.
musicola Lynge
Cetraria andrejevii Oksn.
aurescens Tuck
chlorophylla (Willd.) Vainio
commixta (Nyl.) Th. Fr.
cucullata (Bell.) Ach.
delisei (Bory) Th. Fr.
ericetorum Opiz.
fendleri (Nyl.) Tuck.
halei W. Culb. & C. Culb.
hepatizon (Ach.) Vainio
islandica (L.) Ach.
laevigata Rass
nivalis (L.) Ach.
oakesiana Tuck.
pinastri (Scop.) S. Gray
sepincola (Ehrh.) Ach.
Cladina arbuscula (Wallr.) Rabenh.
mitis (Sandst.) Hale & W. Culb.
rangiferina (L.) Nyl.
stellaris (Opiz) Brodo
Cladonia acuminata (Ach.) Norrl.
alaskana Evans.
amaurocraea (Flk.) Schaer.
bacillaris (Gluck) Nyl.
bellidiflora (Ach.) Schaerer
botrytes (Hag.) Willd.
capitata (Michx.) Spreng.
cariosa (Ach.) Spreng.
carneola (Fr.) Fr.
cenotea (Ach.) Schaer.
cervicornis (Ach.) Flot.
chlorophaea Spreng.
coccifera (L.) Willd.
contocraea (Florke) Spreng.
cornuta (L.) Hoffm.
crispata (Ach.) Flot.
cristatella Tuck.
cryptochlorophaea Asah.
cyanipes (Sommerf.) Nyl.
decorticata (Flk.) Spreng.
deformis (L.) Hoffm.
digitata (L.) Hoffm.
ecmocyna (Ach.) Nyl.
fimbriata (L.) Fr.
furcata (Huds.) Schrad.
gracilis (L.) Willd.
macilenta Hoffm.
macroceras (Florke) Ahti
macrophylla (Ehrh.) Ach.
major (Hag.) Sandst.
maxima (Asah) Ahti
merochlorophaea Asah.
multiformis Merr.
nemoxyna (Ach.) Nyl.
norrlinii Vainio
parasitica (Hoffm.) Hoffm.
phyllophora (Ehrh.) Hoffm.
pleurota (Florke) Schaerer
pocillum (Ach.) Koerb.
pseudorangiformis Asah.
pyxidata (L.) Hoffm.
scabriuscula (Duby) Leight.
squamosa (Scop.) Hoffm.
stellaria (Opiz) Brodo
strepsilis (Ach.) Vain.
stricta (Nyl.) Nyl.
subulata (L.) Wigg
subfurcata (Nyl.) Arn.
sulphurina (Michx.) Fr.
symphycarpa (Ach.) Fr.
transcendens (Vain.) Vain.
turgida (Ehrh.) Hoffm.
uncialis (L.) Wigg.
verticillata (Hoffm.) Schaer.
Coelocaulon aculeatum (Schreb.) Link
muricatum (Ach.) Laundon
Collema bachmanianum (Fink.) Degel.
cristatum (L.) G.H. Webb
limosum (Ach.) Ach.
tenax (Sw.) Ach em. Degel.
tuniforme (Ach.) Ach. em. Degel.
undulatum Laur. ex Flot
Corniculata aculeata (Schreb.) Ach.
divergens Ach.
Cyphelium tigillare (Ach.) Ach.
Dactylina arctica (Richards.) Nyl.
Dermatocarpon fluviatile (G. Web.) Th. Fr.
miniatum (L.) Mann.
lachneum (Ach.) A. L. Sm.
Dimeleana oreina (Ach.) Norm
Diplotomma epipolium (Ach.) Arnold
Ephebe lanata (L.) Vain.
Evernia divaricata (L.) Ach.
mesomorpha Nyl.
thamnodes (Flot.) Nyl.
Fulgensia bracteata (Hoffm.) Ras
Graphis scripta (L.) Ach.
Gyalecta foveolaris (Ach.) Schaerer
Hypogymnia austerodes (Nyl.) Ras
bitteri (Lynge) Ahti
physodes (L.) W. Wats
tubulosa (Schaer.) Hav.
Icmadophila ericetorum (L.) Zahlbr.
Imshaugia aleurites (Ach.) Nyl.
Lasallia papulosa (Ach.) Llano
pensylvanica (Hoffm.) Llano
Lecania erysibe (Ach.) Mudd
Lecanora atrosulphurea (Wahlenb.) Ach.
behringii Nyl.
caesiosulphuria Vainio
chlarotera Nyl.
chrysoleuca (Sm.) Ach.
circumborealis Brodo & Vitik.
contractula Nyl.
dispersa (Pers.) Sommerf.
epibryon (Ach.) Ach.
fuscescens (Sommerf.) Nyl.
impudens Degel.
intricata (Ach.) Ach.
muralis (Schreb.) Tuck.
nordenskioeldii Vainio
polytropa (Ehrh.) Rabenh.
pulicaris (Pers.) Ach.
rugosella Zahlbr.

rupicola (L.) Zahlbr.
subfusca (L.) Ach.
symmicta (Ach.) Ach.
Lecidea anthracophila Nyl.
atrobrunnea (Ramond in Lam. & DC.)
auriculata Th. Fr.
berengeriana (Massal.) Th. Fr.
botryosa (Fr.) Th Fr.
caesioatra Schaerer
erythrophaea Florkke *ex* Sommerf.
granulosa (Hoffm.) Ach.
hypnorum Libert
nylanderi (Anzi) Th. Fr.
plebeja Nyl.
turgidula Fr.
parasema Ach.
rubiformis (Ach.) Wahlenb.
scalaris (Ach.) Ach.
vernalis (L.) Ach.
Lecidella carpathica Korber
elaeochroma (Ach.) Choisy
euphorea (Florke) Hertel
glomerulosa (D.C.) Choisy
stigmatea (ach.) Hertel & Leuckert
wulfenii (Hepp) Korber
Leptogium cyanescens (L.) S.F.Gray
lichenoides (L.) Zahlbr.
saturninum (Dicks.) Nyl.
Lobaria linita (Ach.) Rabenh.
pulmonaria (L.) Hoffm.
scrobiculata (Scop.) DC.
Lopadium pezizoideum (Ach.) Korber
Melanelia disjuncta (Erichs.) Essl.
exasperatula (Nyl.) Essl.
glabratula (Lamy) Essl.
septentrionalis (Lynge) Essl.
sorediosa (Almb.) Essl.
Micarea crassipes (Th. Fr.) Coppins
turfosa (Mass.) Du Reitz
Mycobilimbia obscurata (Sommerf.) Rehm
sabuletorum (Schreber) Hafellner
Mycocalicium subtile (Pers.) Szat.
Ochrolechia androgyna (Hoffm.) Arn.
frigida (Sw.) Lynge
gyalectina (Nyl.) Zahlbr.
inequatula (Nyl.) Zahlbr.
tartarea (L.) Massal.
upsaliensis (L.) Massal.
Ophioparma lapponica (Ras) Haffelner
Nephroma arcticum (L.) Torss.
bellum (Spreng.) Tuck.
expallidum (Nyl.) Nyl.
helveticum Ach.
parile (Ach.) Ach.
Pachyspora verrucosa (Ach.) Massal.
Pannaria hookeri (Borr. *ex* Sm.) Nyl.
pezizoides (G.Web.) Trev.
praetermissa (Nyl.) P.James
Parmelia bolliana Mull. Arg.
borreri Turn.
caperata (L.) Ach.
cetrata Ach.
conspersa (Ach.) Ach.
cumberlandia (Gyeln.) Hale
encausta (Sw.) Nyl.
exasperatula Nyl.
flaventior Stirt.
fraudans Nyl.
molliuscula Ach.
olivacea (L.) Ach.
omphalodes (L.) Ach.
panniformes (Nyl.) Vain.
perlata (L.) Ach.
saxatilis (L.) Ach.
septentrionalis (Lynge) Ahti
squarrosa Hale
stygia (L.) Ach.
subaurifera Nyl.
subrudecta Nyl.
sulcata Tayl.
taractica Krempih.
tasmanica Hook. & Tayl.
tiliacea (Hoffm.) Ach.
ulophyllodes (Vain.) Sav.
Parmeliella arctophila (Th. Fr.) Malme
tryptophylla (Ach.) Mull.Arg.
Parmeliopsis aleurites (Ach.) Nyl.
ambigua (Wulf.) Nyl.
hyperopta (Ach.) Arn.
placorodia (Ach.) Nyl.
subargentifera Nyl.
subaurifera Nyl.
Peltigera aphthosa (L.) Willd.
canina (L.) Willd.
didactyla (With.) Laundon
elisabethae Gyeln.
evansiana Gyel.
hispida (Schreb.) Tuck.
horizontalis (Huds.) Baumg.
lepidophora (Nyl.) Vainio
leucophlebia Gyeln.
malacea (Ach.) Funck
multiformis Merr.
neckeri Hepp
obsessa Mont.
polydactyla (Neck.) Hoffm.
ponojensis Gyeln.
praetextata (Somm.) Vain.
pulverulenta (Schreb.) Nyl.
rufescens (Weis.) Humb.
scabrosa Th. Fr.
spuria (Ach.) DC.
stellaris (L.) Nyl.
venosa (L.) Baumg.
Pertusaria atra Lynge
bryontha (Ach.) Nyl.
bryophaga Erichs.
coriacea (Th. Fr.) Th.Fr.
dactylina (Ach.) Nyl.
panygra (Ach.) Massal.
subdactylina Nyl.
subobducens Nyl.
Phaeophyscia constipata (Norrl. & Nyl.) Moberg
sciastra (Ach.) Moberg
Physcia adscendens Bitt.
aipolia (Ehrh.) Hampe
caesia (Hoffm.) Hampe
ciliata (Hoffm.) DR.
dubia (Hoffm.) Lett.
grisea (Lam.) Zahlbr.
millegrana Degel.
musicgena (Ach.) Nyl.
orbicularis (Neck.) Poetsch.
phaea (Tuck.) Thoms.
sciastra (Ach.) DR.
stellaris (L.) Nyl.
subobscura (Nyl.) Nyl.
syncolla Tuck.
Physconia detersa (Nyl.) Poelt
muscigena (Ach.) Poelt
Phytoconis ericetorum (Pers.) Redh. & Kuyper
Placodium aurantiacum (Lightf.) Hepp.
cerinum (Hoffm.) Hepp.
elegans (Link.) Ach.
vitellinum (Hoffm.) Hepp.
Placopsis gelida (L.) Linds
Placynthium aspratile (Ach.) Henss.
nigrum (Huds.) S.F. Gray
Platismatia glauca (L.) W.Culb. & C. Culb.
Polyblastia bryophila Lonnr.
hyperborea Th. Fr.
Polychidium muscicola (Sw.) S.F. Gray
Polysporina simplex (Dav.) Vezda
Porpidia flavicunda (Ach.) Gowan
Protoparmelia badia (Hoffm.) Hafellner
Pseudephebe minuscula (Nyl. *ex* Arn.) Brodo & Hawksw.
Pseudevernia consocians (Vain.) Hale & Culb.
Psoroma hypnorum (Vahl) S.F. Gray
Pyrrhospora varians (Ach.) R.C. Harris
Ramalina calicaris (L.) E.Fries
farinacea (L.) Ach.
fastigiata (Pers.) Ach.
intermedia (Del. *ex* Nyl.) Nyl.
minuscula (Nyl.) Nyl.
obtusata (Arn.) Bitt.
pollinaria (Westr.)
roesleri (Hochst.) Nyl.
thrausta (Ach.) Nyl.
Rhizocarpon disporum (Naeg.) Mull. Arg.
geographicum (L.) DC.
petraeum (Wulf.) Koerb.
Rinodina archaea (Ach.) Arnold
calcigena (Th. Fr.) Lynge
mniaraea (Ach.) Korber
oreina (Ach.) Mass.
roscida (Sommerf.) Arnold
turfacea (Wahlenb.) Korber
sophodes (Ach.) Koerb.
Sarcogyne regularis Korber
Schaereria tenebrosa (Flowtow) Hertel & Poelt
Solorina bispora Nyl.
octospora (Arn.) Arn.
saccata (L.) Ach.
spongiosa (Sm.) Anzi
Sphaerophorus fragilis (L.) Pers.
globosus (Huds.) Vainio
Sphinctrina turbinata (Pers.) de Not
Staurothele fissa (Taylor) Zwackh
fuscocuprea (Nyl.) Zsch.
Stereocaulon alpinum Laur.
condensatum Hoffm.
dactylophyllum Florke
grande (Magn.) Magn.
paschale (L.) Hoffm.
saxatile Magn.
subcoralloides (Nyl.) Nyl.
tomentosum Fr.
Telochistes chrysophthalmus (L.) Th. Fr.
lychneus (Ach.) Tuck.
polycarpus (Hoffm.) Tuck.
Tephromela armeniaca (DC.) Hertel & Rambold
Thamnolia subuliformis (Ehrh.) W. Culb.
vermicularis (Sw.) Ach. *ex* Schaerer
Toninia caeruleonigricans (Lightf.) Th. Fr.
lobulata (Sommerf.) Lynge
Trapeliopsis granulosa (Hoffm.) Lumbsch.
Tremalecia atrata (Ach.) Hertel
Umbilicaria arctica (Ach.) Nyl.
deusta (L.) Baumg.
hyperborea (Ach.) Hoffm.
mammulata (Ach.) Tuck.
muhlenbergii (Ach.) Tuck.
proboscidea (L.) Schrad.
torrefacta (Lightf.) Schrad.
vellea (L.) Ach.
Urceolaria scruposa (L.) Nyl.
Usnea barbata (L.) E.Fries
cavernosa Tuck.
comosa (Ach.) Ach.
fulvoreagens (Ras.) Ras.
hirta (L.) Wigg.
longissima (L.) Ach.
scabrata Nyl.
subfloridana Stirt
substerilis Mot.
Verrucaria muralis Ach.
nigrescens Pers.
rupestris Schrad.
Xanthoparmelia centrifuga (L.) Hale
conspersa (Ach.) Hale
incurva (Pers.) Hale
plittii (Gyel.) Hale
separata (Th. Fr.) Hale
Xanthoria candelaria)L.) Th. Fr.
elegans (Link.) Th. Fr.
fallax (Hepp) Arn.
polycarpa (Ehrh.) Oliv.
sorediata (Vainio) Poelt
Xylographa abietina (Pers.) Zahlbr.
parallela (Ach.) E.Fries.

BRYOPHYTA (MOSSES & LIVERWORTS) MUSCI (MOSSES)

Aloina brevirostris (Hook. & Grev.) Kindb.
Amblyodon dealbatus (Hedw.) B.S.G.
Amblystegium humile (P. Beauv.) Crundw.
juratzkanum Schimp.
riparium (Hedw.) B.S.G.
serpens (Hedw.) B.S.G.
varium (Hedw.) Lindb.
Andreaea rupestris Hedw.
Anoectangium tenuinerve (Limpr.) Par.
Anomodon attenuatus (Hedw.) Hub.
minor (Hedw.) Furnr.
rostratus (Hedw.) Schimp.
Astomum muhlenbergianum (Sw.) Grout
Atrichum altecristatum (Lindb. & H. Arnell) Kindb.
tenellum (Rohl) B.S.G.
undulatum (Hedw.) P.Beauv.
Aulacomnium acuminatum (Lindb. & H. Arnell) Kindb.
heterostichum (Hedw.) B.S.G.
palustre (Hedw.) Schwaegr.
turgidum (Wahlenb.) Schwaegr.
Barbula convoluta Hedw.
fallax Hedw.
icmadophila Schimp. *ex* C. Mull.
reflexa (Brid.) Brid.
unguiculata Hedw.
Bartramia ithyphylla Brid.
pomiformis Hedw.
Brachythecium acuminatum (Hedw.) Aust.
acutum (Mitt.) Sull.
albicans (Hedw.) B.S.G.
plumosum (Hedw.) B.S.G.
populeum (Hedw.) B.S.G.
reflexum (Starke *ex* Web & Mohr) B.S.G.
rivulare B.S.G.
rutabulum (Hedw.) B.S.G.
salebrosum (Web. & Mohr) B.S.G.
turgidum (C.J. Hartm.) Kindb.
velutinum (Hedw.) B.S.G.
Brotherella recurvans (Michx.) Fleisch
Bryoerythrophyllum recurvirostrum (Hedw.) Chen
Bryum acutiforme Limpr. *ex* Hag.
algovicum Sendtn. *ex* C. Mull.
arcticum (R. Br.) B.S.G.
argenteum Hedw.
blindii B.S.G.
caespiticium Hedw.
calophyllum R.Br.
creberrimum Tayl.
knowltonii Barnes
lisae (B.S.G.) Marg.
lonchocaulon C. Mull.
longisetum Bland *ex* Schwaegr.
pallens (Brid.) Sw. *ex* Rohl.
pallescens Schleich. *ex* Schwaegr.
pseudotriquetrum (Hedw.) Gaertn., Meyer, & Scherb.
salinum Hag. *ex* Limpr.
stenotrichum C. Mull.
teres Lindb.
uliginosum (Brid.) B.S.G.
weigelii Spreng.
wrightii Sull. & Lesq.
Callicladium haldanianum (Grev.) Crum
Calliergon cordifolium (Hedw.) Kindb.
giganteum (Schimp.) Kindb. *ex* Warnst.
richardsonii (Mitt.) Kindb. *ex* Warnst.
sarmentosum (Wahlenb.) Kindb.
stramineum (Brid.) Kindb.
trifarium (Web.) & Mohr) Kindb.
turgescens (T. Jens.) Kindb.
Campylium chrysophyllum (Brid) J. Lange
hispidulum (Brid.) J. Lange
polygamum (B.S.G.) C Jens.
radicale (P. Beauv.) Grout
stellatum (Hedw.) C. Jens.
Catoscopium nigritum (Hedw.) Brid.
Ceratodon purpureus (Hedw.) Brid.
Cinclidium arcticum (B.S.G.) Schimp.
latifolium Lindb.
stygium Sw.
Cirriphyllum cirrosum (Schwaegr. *ex* Schultes) Grout
tenuinerve (Lindb.) Wijk & Marg.
Climacium dendroides (Hedw.) Web. & Mohr
Cnestrum glaucescens (Lindb. & Arn.) Holm. *ex* Mogensen & Steere
Cratoneuron filicinum (Hedw.) Spruce
Cynodontium strumiferum (Hedw.) Lindb.
tenellum (B.S.G.) Limpr.
Cyrtomnium hymenophylloides (Hub) Kop.
Desmatodon cernuus (Hub) B.S.G.
heimii (Hedw.) Mitt.
latifolius (Hedw.) Brid.
obtusifolius (Schwaegr.) Schimp.
systylius Schimp.
Dichelyma capillaceum (With.) Myr.
falcatum (Hedw.) Myr.
Dicranella cerviculata (Hedw.) Schimp.
crispa (Hedw.) Schimp.
grevilleana (Brid.) Schimp.
heteromalla (Hedw.) Schimp.
schreberiana (Hedw.) Schimp.
varia (Hedw.) Schimp.
Dicranoweisia crispula (Hedw.) Lindb. *ex* Milde
Dicranum acutifolium (Lindb. & Arnell) C.Jens. *ex* Weinm.
angustum Lindb.
bonjeanii De Not. *ex* Lisa
elongatum Schleich. *ex* Schwaegr.
flagellare Hedw.
fragilifolium Lindb.
fuscescens Turn.
groenlandicum Brid.
montanum Hedw.
muehlenbeckii B.S.G.
ontariense Peterson
polysetum Sw.
scoparium Hedw.
spadiceum Zett.
tauricum Sapeh.
undulatum Brid.
Didymodon rigidulus Hedw.
Distichium capillaceum (Hedw.) B.S.G.
hagenii Ryan *ex* Philib.
inclinatum (Hedw.) B.S.G.
Ditrichum flexicaule (Schwaegr.) Hampe
Drepanocladus aduncus (Hedw.) Warnst.
badius (C.J. Hartm.) Roth
capillifolius (Warnst.) Warnst.
exannulatus (B.S.G.) Warnst.
fluitans (Hedw.) Warnst.
lycopodioides (Brid.) Warnst.
revolvens (Sw.) Warnst.
sendtneri (Schimp.) Warnst.
tundrae (H. Arn.) Loeske
uncinatus (Hedw.) Warnst.
vernicosus (Lindb. *ex* C. Hartm.) Warnst.
Encalypta alpina Sm.
brevicolla (B.S.G.) Bruch *ex* Angstr.
ciliata Hedw.
procera Bruch
rhaptocarpa Schwaegr.
vulgaris Hedw.
Entodon cladorrhizans (Hedw.) C. Mull.
Eurhynchium pulchellum (Hedw.) Jenn.
riparioides (Hedw.) Rich.
Fissidens bryoides Hedw.
osmundoides Hedw.
Fontinalis antipyretica Hedw.
dalecarlica Schimp. *ex* B.S.G.
hypnoides C.J. Hartm.
macmillani Card.
novae-angliae Sull.
Funaria hygrometrica Hedw.
Grimmia affinis Hoppe & Hornsch. *ex* Hornsch.
alpicola Hedw.
apocarpa Hedw.
tenera Zett.
Gymnostomum aeruginosum Sm.
calcereum Nees, Hornsch., & Sturm
recurvirostrum Hedw.
Gyroweisia tenuis (Hedw.) Schimp.
Haplocladium microphyllum (Hedw.) Broth.
Hedwigia ciliata (Hedw.) P.Beauv.
Helodium blandowii (Web. & Mohr) Warnst.
Herzogiella striatella (Brid.) Iwats.
turfacea (Lindb.) Iwats.
Hygroamblystegium fluviatile (Hedw.) Loeske
tenax (Hedw.) Jenn.
Hygrohypnum alpestre (Hedw.) Loeske
luridum (Hedw.) Jenn.
Hylocomium splendens (Hedw.) B.S.G.
Hypnum bambergeri Schimp.
cupressiforme Hedw.
fertile Sendtn.
hamulosum B.S.G.
lindbergii Mitt.
pallescens (Hedw.) P. Beauv.
pratense Koch *ex* Brid.
recurvatum (Lindb. & H. Arnell) Kindb.
revolutum (Mitt.) Lindb.
subimponens Lesq.
vaucheri Lesq.
Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb.
Kiaeria glacialis (Berggr.) Hag.
starkei (Web. & Mohr) Hag.
Leptobryum pyriforme (Hedw.) Wils.
Leptodictyum brevipes (Card. & Ther. *ex* Holz.) Broth.
riparium (Hedw.) Warnst.
trichopodium (Schultz) Warnst.
Lescuraea patens (Lindb.) H. Arnell & C. Jens.
Leskea gracilescens Hedw.
obscura Hedw.
polycarpa Hedw.
Leskeella nervosa (Brid.) Loeske
Leucobryum glaucum (Hedw.) Angstr. *ex* Fr.
Meesia longiseta Hedw.
triquetra (Richt.) Angstr.
uliginosa Hedw.
Mnium lycopodioides Schwaegr.
spinulosum B.S.G.
thomsonii Schimp.
Myurella julacea (Schwaegr.) B.S.G.
tenerrima (Brid.) Lindb.
Neckera pennata Hedw.
Oncophorus virens (Hedw.) Brid.
wahlenbergii Brid.
Orthothecium chryseum (Schwaegr. *ex* Schultes) B.S.G.
strictum Lor.
Orthotrichum anomalum Hedw.
jamesianum Sull. *ex* James
laevigatum Zett.
obtusifolium Brid.
pumilum Sw.
pylaisii Brid.
sordidum Sull. & Lesq.ex Aust
speciosum Nees *ex* Sturm
strangulatum P. Beauv.
Oxystegus tenuirostre (Hook. & Tayl.)Steere
Paludella squarrosa (hedw.) Brid.
Paraleucobryum longifolium (Hedw.) Brid.
Philonotis fontana (Hedw.) Brid.
Physcomitrella hookeri Hampe
pyriforme (Hedw.) Hampe
Plagiobyrum zierii (Hook.) Lindb.
Plagiomnium ciliare (C.Mull.) Kop.
cuspidatum (Hedw.) Kop.
drummondii (Bruch & Schimp) Kop.
ellipticum (Brid.) Kop.
medium (B.S.G.) Kop.
Plagiothecium denticulatum (Hedw.) B.S.G.
laetum B.S.G.
Platydictya jungermannioides (Brid.) Crum
Platygyrium repens (Brid.) B.S.G.
Pleurozium schreberi (Brid.) Mitt.
Pogonatum alpinum (Hedw.) Rohl.
Pohlia annotina (Hedw.) Lindb.
atropurpurea (Wahlenb.) H. Lindb.
bulbifera (Warnst.) Warnst.
cruda (Hedw.) Lindb.

nutans (Hedw.) Lindb.
proligera (Kindb. *ex* Limpr.) Lindb. & H. Arnell
vexans (Limpr.) H. Lindb.
wahlenbergii (Web. & Mohr) Andr.
Polytrichum commune Hedw.
formosum Hedw.
hyperboreum R.Br.
juniperinum Hedw.
longisetum Brid.
piliferum Hedw.
strictum Brid.
Pseudobryum cinclidioides (Hub) Kop.
Pseudoleskeella papillosa (Lindb.) Kindb.
tectorum (Funck *ex* Brid.) Kindb. *ex* Broth.
Ptilium crista-castrensis (Hedw.) De Not.
Pylaisiella intricata (Hedw.) Grout
polyantha (Hedw.) Grout
Rauiella scita (P. Beauv.) Reim.
Rhabdoweisia crispata (With.) Lindb.
Rhacomitrium canescens (Hedw.) Brid.
lanuginosum (Hedw.) Brid.
Rhizomnium gracile Kop.
pseudopunctatum (Bruch & Schimp.) Kop.
punctatum (Hedw.) Kop.
Rhodobryum roseum (Hedw.) Limpr.
Rhynchostegiella compacta (C. Mull.) Loeske
Rhytidiadelphus triquetris (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.
Saelania glaucescens (Hedw.) Bomanss. & Broth.
Schistidium apocarpum (Hedw.) B. & S. in B.S.G.
rivulare (Brid.) Podp.
Scorpidium scorpioides (Hedw.) Limpr.
turgescens (T. Jens) Loeske
Seligeria calcarea (Hedw.) B.S.G.
campylopoda Kindb. *ex* Mac. & Kindb.
Sphagnum angustifolium (C. Jens. *ex* Russ.) C.Jens.
annulatum Warnst.
balticum (Russ.) Russ. *ex* C. Jens.
capillifolium (Ehrh.) Hedw.
centrale C. Jens. *ex* H. Arnell & C. Jens.
compactum DC. *ex* Lam. & DC.
cuspidatum Ehrh. *ex* Hoffm.
fallax (Klinggr.) Klinggr.
fuscum (Schimp.) Klinggr.
girgensohnii Russ.
jensenii H. Lindb.
lindbergii Schimp. *ex* Lindb.
magellanicum Brid.
nemoreum Scop.
obtusum Warnst.
riparium Angstr.
rubellum Wils.
russowii Warnst.
squarrosum Crome
tenellum (Brid.) Pers. *ex* Brid.
teres (Schimp.) Angstr. *ex* C. Hartm.
warnstorfii Russ.
wulfianum Girg.
Splachnum ampullaceum Hedw.
sphaericum Hedw.
vasculosum Hedw.
Stegonia latifolia (Schwaegr. *ex* Schultes) Vent.
Taxiphyllum deplanatum (Bruch & Schimp. *ex* Sull.) Fleisch.
Tayloria lingulata (Dicks.) Lindb.
serrata (Hedw.) B.S.G.
Tetraphis pellucida Hedw.
Tetraplodon angustatus (Hedw.) B.S.G.
mnioides (Hedw.) B.S.G.
Thuidium abietinum (Hedw.) B.S.G.
delicatulum (Hedw.) B.S.G.
recognitum (Hedw.) Lindb.
Timmia megapolitana Hedw.
norvegica Zett.
Tomenthypnum falcifolium Ren. *ex* Nich.
nitens (Hedw.) Loeske
Tortella fragilis (Drumm.) Limpr.
Tortula amplexa (Lesq.) Steere
mucronifolia Schwaegr.
norvegica (Web.) Wahlenb. *ex* Lindb.
ruralis (Hedw.) Gaertn., Meyer, & Scherb.
vahliana (Schultz.) Mont. in Gay
Ulota crispa (Hedw.) Brid.
curvifolia (Wahlenb.) Lilj.
Weissia controversa Hedw.
Zygodon viridissimus (Dicks.) Brid.

HEPATICAE (LIVERWORTS)

Anastrophyllum minutum (Schreb.) Schust.
Aneura pinquis (L.) Dumort.
Anthelia juratzkana (Limpr.) Trev.
Barbilophozia hatcheri (Evans) Loeske
Blepharostoma trichophyllum (L.) Dum.
Calypogeia muelleriana (Schiffn.) K. Mull.
neesiana (Mass.) Loeske
Cephalozia lunulifolia (Dum.) Dum.
Lepidozia reptans (L.) Dum.
Lophozia attenuata (Mart.) Dum.
incisa (Schrad.) Dumort.
kunzeana (Hub.) Evans.
Marchantia polymorpha L.
Moerckia hibernica (Hook.) Gott.
Odontoschisma macounii (Aust.) Underw.
Plagiochila porelloides (Torry *ex* Nees) Lindenb.
Ptilidium ciliare (L.) Hampe
pulcherrimum (G. Web) Hampe
Scapania curta (Moart.) Dum.

PTERIDOPHYTA (FERNS AND FERN ALLIES)

EQUISETACEAE (HORSE-TAIL FAMILY)

Equisetum arvense L. **Common Horsetail**
fluviatile L. **Swamp Horsetail**
hyemale L. **Common Scouring-rush**
laevigatum A. Br. **Smooth Scouring-rush**
palustre L. **Marsh Horsetail**
pratense Ehrh. **Meadow Horsetail**
scirpoides Michx. **Dwarf Scouring-rush**
sylvaticum L. **Wood Horsetail**
variegatum Schleich. **Variegated Horsetail**

LYCOPODIACEAE (CLUB-MOSS FAMILY)

Lycopodium annotinum L. **Stiff Club-moss**
clavatum L. **Running Pine**
complanatum L. **Trailing Club-moss**
dendroideum Michx. **Ground-pine**
lucidulum Michx **Shining Club-Moss**
selago L. **Mountain-Club-moss**
sitchense Rupr. **Ground-Fir**
tristachyum Pursh **Ground-Cedar**

SELAGINELLACEAE (SPIKEMOSS FAMILY)

Selaginella densa Rydb. **Prairie Selaginella**
rupestris (L.) Spring
selaginoides (L.) Link

ISOETACEAE (QUILLWORT FAMILY)

Isoetes echinospora Dur.

OPHIOGLOSSACEAE (ADDER'S TONGUE FAMILY)

Botrychium lunaria (L.) Sw. **Moonwort**
matricariaefolium A.Br.
minganense Vict.
multifidum (Gmel.) Rupr. **Leathery Grape-Fern**
virginianum (L.) Sw. **Rattlesnake-fern**

OSMUNDACEAE (FLOWERING FERN FAMILY)

Osmunda claytoniana L. **Interrupted Fern**

POLYPODIACEAE (FERN FAMILY)

Athyrium filix-femina (L.) Roth **Lady Fern**
Cryptogramma crispa (L.) R.Br. **Parsley Fern**
Cystopteris bulbifera (L.) Bernh. **Bulbet-fern**
fragilis (L.) Bernh. **Fragile Fern**
Dryopteris cristata (L.) Gray **Crested Shield Fern**
earthusiana (Vill.) H.P.Fuchs Woynar **Spinulose Shield Fern**
fragrans (L.) Schott **Fragrant Shield Fern**
Gymnocarpium dryopteris (L.) Newm. **Oak-fern**
jessoense (Koidz.) Koidz. **Northern Oak-Fern**
Matteuccia struthiopterus (L.) Todaro **Ostrich Fern. Fiddle Heads**
Onoclea sensibilis L. **Sensitive Fern**
Pellaea glabella Mett. **Purple Cliff Brake**
Phagopteris connectitis (Michx.) Watt **Beech-Fern**
Polypodium virginianum L. **Rock-Polypody**
Pteridium aquilinum (L.) Kuhn Brake. **Bracken Fern**
Thelypteris palustris (Salisb.) Schott **Marsh Fern**
Woodsia alpina (Bolton) S.F. **Gray Northern Woodsia**
glabella R.Br. **Smooth Woodsia**
ilvensis (L.) R.Br. **Rusty Woodsia**
oregana Eat. **Blunt-lobed or Large Woodsia**
scopulina Eat. **Rocky Mountain Woodsia**

SPERMATOPHYTA (SEED PLANTS)

GYMNOSPERMAE (GYMNOSPERMS)

TAXACEAE (YEW FAMILY)

Taxus canadensis Marsh. **Canada Yew**

PINACEAE (PINE FAMILY)

Abies balsamea (L.) Mill. **Balsam Fir**
Juniperus communis L. **Common Juniper**
horizontalis Moench **Creeping Savin**
Larix laricina (Du Roi) K.Koch **Tamarack or Larch**
Picea glauca (Moench) Voss **White Spruce**
mariana (Mill.) B.S.P. **Black Spruce**
Pinus banksiana Lamb. **Jack Pine**
resinosa Ait. **Red or Norway Pine**
strobus L. **Eastern White Pine**
Thuja occidentalis L. **Eastern White Cedar**

ANGIOSPERMAE (ANGIOSPERMS)

MONOCOTYLEDONS

TYPHACEAE (CAT-TAIL FAMILY)

Typha angustifolia L. **Narrow -leaved Cat-tail**
glauca Godron
latifolia L. **Common Cat-tail**

SPARGANIACEAE (BUR-REED FAMILY)

Sparganium angustifolium Michx. **Narrow-leaved Bur-reed**
chlorocarpum Rydb. **Stemless Bur-reed**
eurycarpum Engelm. **Broad-fruited Bur-reed**
hyperboreum Laestad **Northern Bur-reed**
minimum (Hartm.) Fries **Small Bur-reed**
multipedunculatum (Morong) Rydb. **Many Stalked Bur-reed**

ZOSTERACEAE (PONDWEED FAMILY)

Potamogeton alpinus Balbis **Northern Pondweed**
amplifolius Tuck. **Large-leaved Pondweed**
berchtoldii Fieber **Pondweed**
epihydrus Raf. **Nutall's Pondweed**
filiformis Pers. **Filiform Pondweed**
foliosus Raf. **Leafy Pondweed**
friesii Rupr. **Fries' Pondweed**
gramineus L. **Various-Leaved Pondweed**
illinoensis Morong **Illinois Pondweed**
natans L. **Common Floating Pondweed**
obtusifolius Mert. & Koch **Blunt-leaved Pondweed**
pectinatus L. **Sago Pondweed. Fennel-leaved Pondweed**
perfoliatus L. **Sago Clasping-leaved Pondweed**
praelongus Wulfen **White-stemmed Pondweed**
pusillus L. **Small Pondweed**

robbinsii Oakes **Robbin's Pondweed**
spirillus Tuckerm. **Sago Pondweed. Fennel-leaved Pondweed**
strictifolius Benn.
vaginatus Turcz. **Sheathed Pondweed**
zosteriformis Schum. **Eelgrass Pondweed**
Ruppia occidentalis Watson **Western Ditch-grass**
Zanichellia palustris L. **Horned-Pondweed**
Zostera marina L. **Eelgrass, Grass-wrack, Sea-wrack**

NAJADACEAE (NAIAD FAMILY)

Najas flexilis (Willd.) Rostk. & Schmidt **Slender Naiad**

JUNCAGINACEAE (ARROW-GRASS FAMILY)

Scheuchzeria palustris L.
Triglochin maritima L. **Seaside Arrow-grass**
palustris L. **Marsh Arrow-grass**

ALISMATACEAE (WATER-PLANTAIN FAMILY)

Alisma gramineum Gmel. **Narrow-leaved Water-plantain**
plantago-aquatica L. **Common Water-plantain**
Sagittaria cuneata Sheldon **Arum-leaved Arrowhead**
latifolia Willd. **Broad-leaved Arrowhead**
rigida Pursh **Sessile-fruited Arrowhead**

BUTOMACEAE (FLOWERING RUSH FAMILY)

Butomus umbellatus L.

HYDROCHARITACEAE (FROG'S BIT FAMILY)

Elodea canadensis Michx. **Canada Waterweed**
Vallisneria americana Michx. **Water-celery**

GRAMINEAE (GRASS FAMILY)

Agropyron pectiniforme R & S **Crested Wheat Grass**
dasystachyum (Hook) Scribn. **Northern Wheat Grass**
repens (L.) Beauv. **Couch-grass. Quack-grass**
sibiricum (Willd.) Beauv.
smithii Rydb. **Western Wheatgrass**
trachycaulum (Link) Malte
triticeum Gaertn. **Annual Wheat Grass**
violaceum (Hornem.) Lange **Purplish Wheat-grass**
Agrostis borealis Hartm. **Northern Bent Grass**
hyemalis (Walt.) BSP. **Hair Grass. Tickle Grass**
stolonifera L. **Redtop**
Alopecurus aequalis Sobol. **Short-awned Foxtail**
alpinus Sm. **Alpine Foxtail**
pratensis L. **Meadow Foxtail**
Andropogon gerardi Vitman **Big Bluestem**
hallii Hack **Sand Bluestem**
scoparius Michx. **Little Bluestem**
Arctagrostis latifolia (R. Br.) Griseb.
Arctophila fulva (Trin.) Rupr.
Aristida longiseta Steud. **Red Three-Awn**
Avena fatua L. **Wild Oat**
sativa L. **Oat**
Beckmannia syzigachne (Steud.) Fern. **Slough Grass**
Bouteloua curtipendula (Michx.) Torr. **Side-Oats Grama**
gracilis (HBK.) Lag. **Blue Grama**
Bromus canadensis Michx.
ciliatus L. **Fringed Brome**
inermis Leys. **Awnless, Smooth or Hungarian Brome**
japonicus Thunb. **Japanese Chess**
porteri (Coult.) Nash **Porter's Chess**
pubescens Muhl.
pumpellianus Scribn. **Canada Brome**
purgans L. **Canada Brome**
squarrosus L. **Field Brome**
tectorum L. **Downy Chess**
Buchloe dactyloides (Nutt.) Engelm. **Buffalo Grass**
Calamagrostis canadensis (Michx.) Nutt. **Marsh Reed Grass**
deschampsioides Trin.
inexpansa Gray **Northern Reed Grass**
lapponica (Wahl.) Hartm.
montanensis Scribn. **Plains Reed Grass**
neglecta (Ehrh.) Gaertn., Mey. & Scherb. **Narrow Reed Grass**
purpurascens R. Br. **Purple Reed Grass**
rubescens Buckl. **Pine Reed Grass**
Calamovilfa longifolia (Hook.) Scribn. **Sand Grass**
Catabrosa aquatica (L.) Beauv. **Brook Grass**
Cinna latifolia (Trev.) Griseb. **Slenderwood Grass**
Dactylis glomerata L. **Orchard Grass**
Danthonia intermedia Vasey **Timber Oat Grass**
spicata (L.) Beauv. **Poverty Oat Grass**
Deschampsia atropurpurea (Wahl.) Scheele **Mountain Hair Grass**
caespitosa (L.) Beauv. **Tufted Hair Grass**
Digitaria ischaemum (Schreb.) Muhl. **Smooth Crabgrass**
sanguinalis (L.) Scop. **Crabgrass**
Distichlis stricta (Torr.) Rydb. **Alkali-grass**
Dupontia fisheri R.Br. **Fisher's Dupontia**
Echinochloa crusgalli (L.) Beauv. **Barnyard Grass**
Elymus canadensis L. **Canada Wild Rye**
diversiglumis Scribn. & Ball **Various-glumed Wild Rye**
glaucus Buckl. **Smooth Wild Rye**
hystrix L. **Bottle-brush Grass**
innovatus Beal **Hairy Wild Rye**
junceus Fisch. **Russian Wild Rye**
mollis Trin. **Sea Lyme Grass, Strand-Wheat**
virginicus L. Virginia **Wild Rye**
Eragrostis hypnoides (Lam.) BSP. **Creeping Teal Love Grass**
megastachya (Koel.) Link **Stink, Skunk, or Snake Grass**
Eremopoa persica (Trin.) Rosher
Festuca altaica Trin. **Northern Rough Fescue**
elatior L. **Meadow Fescue**
obtusa Biehler **Nodding Fescue**
ovina L. **Sheep Fescue**
rubra L. **Red Fescue**
Glyceria borealis (Nash) Batchelder **Northern Manna Grass**
canadensis (Michx.) Trin. **Rattlesnake Grass**
grandis Wats. **Tall Manna Grass**
pulchella (Torr.) Trin. **Graceful Manna Grass**
striata (Lam.) Hitchc. **Fowl Manna Grass**
Helictotrichon hookeri (Scribn.) Henr. **Hooker's Oat Grass**
Hierochloe alpina (Sw.) R. & S. **Holy Grass**
odorata (L.) Beauv. **Vanilla, Indian or Sweet Grass**
pauciflora R. Br. **Arctic Holy Grass**
Hordeum jubatum L. **Wild Barley**
Koeleria cristata (L.) Pers. **June Grass**
Leersia oryzoides (L.) Sw. **Rice Cut Grass**
Lolium multiflorum Lam. **Italian Rye Grass**
perenne L. **Perennial Rye Grass or Common Darnel**
persicum Boiss. & Hohen **Persian Darnel**
temulentum L. **Darnel. Poison Darnel**
Milium effusum L. **Millet Grass. Millet**
Muhlenbergia asperifolia (Nees & Mey.) Parodi **Scratch Grass**
cuspidata (Nutt.) Rydb. **Prairie Muhly**
glomerata (Willd.) Trin. **Bog Muhly**
mexicana (L.) Trin. **Wood Muhly**
racemosa (Michx.) BSP. **Marsh Muhly**
richardsonis (Trin.) Rydb. **Mat Muhly**
Oryzopsis asperifolia Michx. **White-Grained Mountain Rice Grass**
hymenoides (R. & S.) Ricker **Silk Grass. Indian Rice Grass**
micrantha (Trin. & Rupr.) Thurb. **Littleseed Rice Grass**
pungens (Torr.) Hitchc. **Northern Rice Grass**
Panicum capillare L. **Witch Grass**
depauperatum Muhl. **Starved Panic-grass**
lanuginosum Ell. **Soft Millet**
liebergii (Vasey) Scribn. **Lieberg's Panic-grass**
linearifolium Scribn. **Low- White-haired Panic-grass**
miliaceum L. **Millet, Brown Millet**
oligosanthes Schultes **Few-flowered Panic-grass**
perlongum Nash **Long-stalked Panic-grass**
virgatum L. **Switch Grass**
wilcoxianum Vasey **Sand Millet**
xanthophysum Gray **Slender Panic-grass**
Phalaris arundinacea L. **Reed Canary Grass**
canariensis L. **Birdseed or Canary Grass**
Phleum pratense L. **Timothy**
Phragmites australis (Cav.) Trin **Common Reed Grass**
Poa alpina L. **Alpine Blue Grass**
annua L. **Annual Blue Grass**
arctica R. Br. **Arctic Blue Grass**
arida Vasey **Plains Blue Grass**
compressa L. **Canada Blue Grass**
cusickii Vasey. **Early Blue Grass**
fendleriana (Steud.) Vasey **Mutton Grass**
glauca Vahl **Glaucous Spear-grass**
nemoralis L. **Wood Blue Grass**
nervosa (Hook.) Vasey **Wheeler's Blue Grass**
palustris L. **Fowl Blue Grass**
pratensis L. **Kentucky Bluegrass**
Polypogon monspeliensis (L.) Desf. **Rabbit Foot Grass**
Puccinellia ambigua Soer.
deschampsioides Sorensen
distans (L.) Parl. **Slender Salt-meadow Grass**
langeana (Berl.) Soer.
lucida Fern. & Weath.
nuttalliana (Schultes) Hitchc. **Nuttall's Salt-meadow Grass**
phryganodes (Trin.) Scribn. & Merr.
pumila Hitchc.
vaginata (Lange) Fern. & Weath.
Schedonnardus paniculatus (Nutt.) Trel. **Tumble Grass**
Schizachne purpurascens (Torr.) Swallen **False Melic-Grass. Purple Oat Grass**
Scolochloa festucacea (Willd.) Link. **Sprangletop**
Secale cereale (L.) Rye
Setaria glauca (L.) Beauv. **Yellow Foxtail**
verticillata (L.) Beauv. **Foxtail Grass**
viridis (L.) Beauv. **Green Foxtail. Bottle-Grass**
Sorghastrum nutans (L.) Nash **Indian Grass**
Spartina gracilis Trin. **Alkali Cord Grass**
pectinata Link **Fresh-water or Prairie Cord Grass. Slough-Grass**
Sphenopholis intermedia Rydb. **Slender Wedge Grass**
obtusata (Michx.) Scribn. **Prairie Wedge Grass**
Sporobolus cryptandrus (Torr.) Gray **Sand Dropseed**
heterolepis Gray **Prairie Dropseed**
neglectus Nash **Annual Dropseed**
Stipa comata Trin. & Rupr. **Needle-and-thread, Spear Grass**
richardsonii Link Richardson **Needle Grass**
spartea Trin. **Western Porcupine Grass**
viridula Trin. **Feather-bunchgrass. Green Needle Grass**
Toreyochloa pallida (Torr) Church R
Trisetum spicatum (L.) Richter **Spike Trisetum**
Triticum turgidum L. **Wheat**
Zizania aquatica L. **Annual Wild-Rice**

CYPERACEAE (SEDGE FAMILY)

Carex adelostoma Krecz.
adusta Boott **Browned Sedge**
aenea Fern. **Fernald's Hay Sedge**
alopecoidea Tuckerm. **Foxtail Sedge**
amblyorhyncha Krecz.
aquatilis Wahl. **Water Sedge**
arcta Boott **Narrow Sedge**
arctata Boott
argyrantha Tuckerm. **Silvery-flowered Sedge**
assiniboinensis Boott **Assiniboia Sedge**
atherodes Spreng. **Awned Sedge**
atrata L. **Drooping Wood Sedge**
atratiformis Britt. **Black Sedge**
atrofusca Schk. **Dark-brown Sedge**
aurea Nutt. **Golden Sedge**
backii Boott **Back's Sedge**
bebbii Olney **Bebb's Sedge**
bicknellii Britt. **Bicknell's Sedge**
bicolor Bellardi **Two-colored Sedge**
bigelowii Torr. **Stiff Sedge**
brevior (Dew.)
brunnescens (Pers.) Poir. **Brownish Sedge**
buxbaumii Wahl. **Brown Sedge**
canescens L. **Silvery or Hoary Sedge**
capillaris L. **Hair-like Sedge**
capitata L. **Capitate Sedge**
castanea Wahl **Chestnut Sedge**
cephalophora Muhl. **Oval-headed Sedge**
chordorrhiza L.f. **Prostrate Sedge**

communis Bailey **Fibrous-rooted Sedge**
concinna R. Br. **Beautiful Sedge**
convoluta Mack.
crawei Dew. **Crawe's Sedge**
crawfordii Fern. **Crawford's Sedge**
crinita Lam. **Long-haired Sedge**
cristatella Britt.
cumulata (Bailey) Mack.
deflexa Hornem. **Bent Sedge**
deweyana Schwein. **Dewey's Sedge**
diandra Schrank **Two-stamened Sedge**
disperma Dew. **Two-seeded Sedge**
douglasii Boott **Douglas Sedge**
eburnea Boott **Bristle-leaved Sedge**
filifolia Nutt. **Thread-leaved Sedge**
flava L. **Yellow Sedge**
garberi Fern.
glacialis Mack. **Glacier Sedge**
glareosa Wahl **Weak-clustered Sedge**
gracillima Schwein. **Slender Sedge**
granularis Muhl. **Granular Sedge**
gravida Bailey **Heavy Sedge**
gynocrates Wormskj. **Northern Bog Sedge**
hallii Olney
heleonastes Ehrh. **Hudson Bay Sedge**
hookerana Dew. **Hooker's Sedge**
houghtonii Torr. **Sand Sedge**
hystricina Muhl. **Porcupine Sedge**
interior Bailey **Inland Sedge**
intumescens Rudge **Swollen Sedge**
lachenalii Schkuhr. **Arctic Hare's-foot**
lacustris Willd. **Lakeshore Sedge**
laeviconica Dew. **Smooth-fruited Sedge**
langeana Fern.
lanuginosa Michx. **Woolly Sedge**
lasiocarpa Ehrh. **Hairy-fruited Sedge**
laxiflora Lam. **Pleasing Sedge**
lenticularis Michx. **Lens-fruited Sedge**
leptalea Wahl. **Bristle-stalked Sedge**
limosa L. **Mud Sedge**
livida (Wahl.) Willd. **Livid Sedge**
loliacea L. **Rye-grass Sedge**
mackenziei Krecz. **Mackenzie Sedge**
macloviana d'Urv. **Thick-spike Sedge**
maritima Gunn. **Seaside Sedge**
meadii Dew. **Mead's Sedge**
media R. Br.
membranacea Hook.
merritt-fernaldii Mack.
microglochin Wahl. **Short-awned Sedge**
misandra R. Br. **Nodding Sedge**
molesta Mack
muricata L.
muskingumensis Schwein. **Muskingum Sedge**
nigromarginata Schw. **Black-margined Sedge**
normalis Mack. **Larger Straw Sedge**
norvegica Retz. **Norway Sedge**
obtusata Lilj. **Blunt Sedge**
oligosperma Michx. **Few-fruited Sedge**
paleacea Wahl. **Chaffy Sedge**
parryana Dew. **Parry's Sedge**
pauciflora Lightf. **Few-flowerd Sedge**
paupercula Michx. **Bog Sedge**
pedunculata Muhl. **Stalked Sedge**
pensylvanica Lam. **Sun-loving Sedge**
physocarpa Presl.
praegracilis Boott **Graceful Sedge**
prairea Dew. **Prairie Sedge**
praticola Rydb. **Northern Meadow Sedge**
projecta Mack. **Necklace Sedge**
pseudo-cyperus L. **Cyperus-like Sedge**
rariflora (Wahl.) Sm. **Scant Sedge**
retrorsa Schwein. **Turned Sedge**
richardsonii R. Br. **Richardson's Sedge**
rosea Schk. **Stellate Sedge**
rossii Boott **Ross' Sedge**
rostrata Stokes **Beaked Sedge**
rotundata Wahl. **Round Sedge**
rufina Drej. **Reddish Sedge**
rupestris All. **Rock Sedge**
salina Wahl. **Salt Sedge**
sartwellii Dew. **Sartwell's Sedge**
saxatilis L. **Rocky -ground Sedge**
scirpoidea Michx. **Rush-like Sedge**
scoparia Schk. **Broom Sedge**
siccata Dew. **Hay Sedge**
sprengelii Dew. **Sprengel's Sedge**
stenophylla Wahl. **Low Sedge**
stipata Muhl. **Awl-fruited Sedge**
stricta Lam. **Erect Sedge**
subspathacea Wormsk. **Hoppner's Sedge**
supina Wahl. **Weak Sedge**
sychnocephala Carey **Dense Long-beaked Sedge**
tenera Dew.
tenuiflora Wahl. **Thin-flowered Sedge**
tetanica Schkuhr **Rigid Sedge**
tonsa (Fern.) Bickn. **Bald Sedge**
torreyi Tuckerm. **Torrey's Sedge**
trisperma Dew. **Three-sided Sedge**
umbellata Schkuhr. **Umbellate Sedge**
ursina Dewey **Bear Sedge**
vaginata Tausch **Sheathed Sedge**
vesicaria L. **Blister Sedge**
viridula Michx. **Green Sedge**
vulpinoidea Michx. **Fox Sedge**
williamsii Britt.
woodii Dew.
xerantica Bailey **White-scaled Sedge**
Cladium mariscoides (Muhl.) Torr. **Twig Rush, Water Bog-rush**
Cyperus erythrorhizos Muhl. **Red-rooted Nut-grass**
houghtonii Torr. **Houghton's Nut-grass**
inflexus Muhl. **Awned Nut-grass**
schweinitzii Torr. **Sand Nut-grass**
strigosus L. **Straw-colored Nut-grass**
Dulichium arundinaceum (L.) Britt. **Three-way sedge**
Eleocharis acicularis (L.) R. & S. **Needle Spike-rush**
compressa Sulliv. **Flattened Spike-rush**
engelmannii Steud. **Engelmann's Spike-rush**
erythropoda Steud.
halophila Fern. & Brack
obtusa (Willd.) Schultes **Blunt Spike-rush**
palustris (L.) R. & S. **Creeping Spike-rush**
smallii Britt. **Small's Spike-rush**
tenuis (Willd.) **Schultes Slender Spike-rush**
uniglumis (Link) **Schultes One-glumed Spike-rush**
Eriophorum angustifolium Honckeny **Tall Cotton-grass**
brachyantherum Trautv. **Close-sheathed Cotton-grass**
callitrix Cham. **Beautiful Cotton-grass**
chamissonis Mey. **Russet Cotton-grass**
gracile Koch **Slender Cotton-grass**
russoleum Fries
scheuchzeri Hoppe **One-spike Cotton-grass**
spissum Fern.
vaginatum L **Sheathed Cotton-grass**
viridi-carinatum (Engelm.) Fern. **Thin-leaved Cotton-grass**
Kobresia bellardii (All.) Degl. **Bellard's Kobresia**
simpliciuscula (Wahl.) Mack. **Simple Bog-sedge**
Rhynchospora alba (L.) Vahl **White Beak-rush**
capillacea Torr. **Slender Beak-rush**
capitellata (Michx.) Vahl
Scirpus americanus Pers. **Chair-maker's Rush. Three-square Bulrush**
atrocinctus Fern
atrovirens Willd. **Green Bulrush**
caespitosus L. **Tufted Bulrush**
cyperinus (L.) Kunth **Wool-grass**
fluviatilis (Torr.) Gray **River Bulrush**
hudsonianus (Michx.) Fern. **Alpine Cotton-grass**
lacustris (Vahl.) Kern
maritimus L.
microcarpus Presl **Small-fruited Bulrush**
nevadensis Wats. **Nevada Bulrush**
rubrotinctus Fern. **Small-fruited Bullrush**
rufus (Huds.) Schrad. **Red Bulrush**
subterminalis Torr. **Water Bullrush**

***ARACEAE* (ARUM FAMILY)**

Acorus calamus L. **Sweetflag. Flagroot**
Arisaema atrorubens (Ait.) Blume **Jack-in-the-pulpit, Indian Turnip**
Calla palustris L. **Water-Arum**

***LEMNACEAE* (DUCKWEED FAMILY)**

Lemna minor L. **Lesser Duckweed**
trisulca L. **Star-Duckweed. Ivy-leaved Duckweed**
turionifera Landolt
Spirodela polyrhiza (L.) Schleid. **Water-flaxseed. Larger Duckweed**
Wolffia columbiana Karsten

***ERIOCAULACEAE* (PIPEWORT FAMILY)**

Eriocaulon septangulare With. **White-buttons. Duckgrass**

***COMMELINACEAE* (SPIDERWORT FAMILY)**

Tradescantia occidentalis (Britt.) Smyth **Western Spiderwort**

***PONTEDERIACEAE* (PICKEREL-WEED FAMILY)**

Heteranthera dubia (Jacq) MacM. **Water Ster-grass**

***JUNCACEAE* (RUSH FAMILY)**

Juncus alpinus Vill. **Alpine Rush**
arcticus Willd. **Arctic Rush**
balticus Willd. **Baltic Rush**
biglumis L. **Two-glumed Rush**
brevicaudatus (Engelm.) Fern. **Short-tail Rush**
bufonius L. **Toad Rush**
castaneus Sm. **Chestnut Rush**
compressus Jacq. **Flattened Rush**
dudleyi Wieg. **Dudley's Rush**
filiformis L. **Thread Rush**
gerardii Loisel. **Black-grass**
interior Wieg. **Inland Rush**
longistylis Torr. **Long-styled Rush**
nodosus L. **Knotted Rush**
stygius L. **Moor Rush**
tenuis Willd. **Slender Rush**
torreyi Coville **Torrey's Rush**
triglumis L. **Three-flowered Rush**
vaseyi Engelm. **Big-head Rush**
Luzula acuminata Raf.
confusa Lindb. **Northern Wood-rush**
groenlandica Bocher **Greenland Wood-rush**
multiflora (Retz.) Lejeune
parviflora (Ehrh.) Desv. **Small-flowered Wood-rush**
spadicea (All.) DC.
spicata (L.) DC. **Spiked Wood-rush**

***LILIACEAE* (LILY FAMILY)**

Allium cernuum Roth **Nodding Onion**
schoenoprasum L. **Wild Chives**
stellatum Fraser **Wild Onion. Pink-flowered Onion**
textile Nels. & Macbr. **Prairie Onion**
tricoccum Ait. **Wild Leek**
Asparagus officinalis L. **Garden Asparagus**
Clintonia borealis (Ait.) Raf. **Bluebead Lily**
Disporum trachycarpum (Wats.) B. & H. **Fairybells**
Lilium philadelphicum L. **Wood Lily**
Maianthemum canadense Desf. **Two-leaved Solomon's-seal**
Polygonatum biflorum (Walt.) Ell. **Hairy Solomon's Seal**
Smilacina racemosa (L.) Desf. **False Spikenard**
stellata (L.) Desf. **Star-flowered Solomon's Seal**
trifolia (L.) Desf. **Three-leaved Solomon's Seal**
Smilax herbacea L. **Carrion Flower**
Streptopus amplexifolius (L.) DC. **White Mandarin. Clasping-leaved Twisted Stalk**
S. roseus **Michx. Rose Mandarin**
Tofieldia glutinosa (Michx.) Pers. **Sticky Asphodel**
pusilla (Michx.) Pers. **Bog Asphodel**
Trillium cernuum L. **Nodding Trillium. Nodding Wakerobin**
Uvularia sessilifolia L. **Small Bellwort**
Zigadenus elegans Pursh **White Camas. Smooth Camas**

AMARYLLIDACEAE (AMARYLLIS FAMILY)

Hypoxis hirsuta (L.) Coville **Common Stargrass, Yellow Stargrass**

IRIDACEAE (IRIS FAMILY)

Iris germanica L. **German Iris**
pseudacorus L. **Yellow Iris of Europe, Water Flag**
versicolor L. **Blue Flag**
Sisyrinchium montanum Greene **Common Blue-eyed Grass**
mucronatum Michx. **Michauxe's Blue-eyed Grass**

ORCHIDACEAE (ORCHID FAMILY)

Arethusa bulbosa L. **Swamp-pink, Dragon's-mouth**
Calopogon pulchellus (Salisb.) R. Br. **Purple Grass-pink, Swamp-pink, Grass-pink Orchid**
Calypso bulbosa (L.) **Oakes Calypso, Venus-slipper**
Coeloglossum viride Hartman **Frog-orchis**
Corallorhiza maculata Raf. **Large or Spotted Coralroot**
striata Lindl. **Striped Coralroot**
trifida Chat. **Early Coralroot**
Cypripedium acaule Ait. **Stemless Lady's-slipper, Moccasin-flower**
arietinum R. Br. **Ram's-head Lady's-slipper**
calceolus L. **Yellow Lady's-slipper**
candidum Muhl. **Small White Lady's-slipper**
passerinum Richards. **Northern or Sparrow's-egg Lady's-slipper**
reginae Walt. **Showy Lady's-Slipper**
Goodyera repens (L.) R. Br. **Lesser Rattlesnake-plantain**
tesselata Lodd. **Loddiges' Rattlesnake-plantain**
Liparis loeselii (L.) **Richard Yellow Twayblade**
Listera auriculata Wieg. **Auricled Twayblade**
borealis Morong **Northern Twayblade**
cordata (L.) R. Br. **Heartleaf Twayblade**
Malaxis monophyllos (L.) Sw. **White Adder's-mouth**
paludosa (L.) Sw. **Bog Adder's-mouth**
unifolia Michx. **Green Adder's-mouth**
Orchis rotundifolia Banks **Small or Round-leaved Orchis**
Platanthera dilatata (Pursh) Hook.
hookeri (Torr.) Lindl.
hyperborea Lindley
lacera (Michx.) G. Don
obtusata Lindley
orbiculata (Pursh) Lindl.
praeclara Sheviak & Boles
psycodes (L.) Lindley **Small Purple-fringed Orchid**
Pogonia ophioglossoides (L.) Ker **Pogonia, Beard-flower, Rose Pogonia**
Spiranthes lacera Raf. **Northern Slender Lady's-tresses**
magnicamporum Sheviak **Great Plains Lady's Tresses**
romanzoffiana Cham. **Hooded Lady's-tresses**

DICOTYLEDONS

SALICACEAE (WILLOW FAMILY)

Populus alba L. **White or Silver-leaved Poplar**
balsamifera L. **Balsam Poplar**
deltoides Bartr. **Eastern Cottonwood, Cottonwood**
grandidentata Michx. **Large-toothed Aspen**
tremuloides Michx. **Trembling Aspen, Aspen Poplar**
Salix alaxensis (Anderss.) Cov. **Alaska Willow**
alba L. **White Willow**
amygdaloides Anderss. **Peach-leaved Willow**
arbusculoides Anderss. **Shrubby Willow**
arbutifolia Pallas
arctophila Cockerell **Trailing Willow**
bebbiana Sarg. **Bebb or Beaked Willow**
brachycarpa Nutt. **Short-capsuled Willow**
calcicola Fern. & Wieg. **Lime Willow**
candida Flugge **Hoary Willow**
discolor Muhl **Pussy Willow, Diamond Willow**
exigua Nutt. **Sandbar Willow**
farriae Ball
fragilis L. **Brittle Willow**
fuscescens Anderss.
glauca L. **Smooth Willow**
herbacea L. **Dwarf Willow, Herb-like Willow**
humilis Marsh. **Gray Willow**
lucida Muhl **Shining Willow**
lutea Nutt. **Yellow Willow**
maccalliana Rowlee **Velvet-fruited Willow**
monticola Bebb. **Mountain Willow**
myrtillifolia Anderss. **Myrtle-leaved Willow**
pedicellaris Pursh **Bog Willow**
pellita Anderss. **Satin Willow**
petiolaris Sm. **Basket Willow**
phylicifolia L. **Tea-leaved Willow**
pyrifolia Anderss. **Balsam Willow**
reticulata L. **Snow Willow**
scouleriana Barratt **Scouler Willow**
serissima (Bailey) Fern. **Autumn Willow**
vestita Pursh **Rock Willow**

MYRICACEAE (WAX-MYRTLE FAMILY)

Myrica gale L. **Sweet Gale, Bog-myrtle**

BETULACEAE (BIRCH FAMILY)

Alnus crispa (Ait.) **Green or Mountain Alder**
rugosa (Du Roi) Spreng. **Speckled Alder**
Betula glandulosa Michx. **Dwarf Birch**
occidentalis Hook. **River or Water Birch**
papyrifera Marsh. **Canoe, White or Alaska Birch**
pendula Roth **European Birch**
pumila L. **Swamp Birch**
Corylus americana Walt. **American Hazelnut**
cornuta Marsh. **Beaked Hazelnut**
Ostrya virginiana (Mill.) Koch **Hop-hornbeam**

FAGACEAE (BEECH FAMILY)

Quercus macrocarpa Michx. **Bur or Mossy-cup Oak**

ULMACEAE (ELM FAMILY)

Celtis occidentalis L. **Hackberry, Nettle-tree**
Ulmus americana L. **American or White Elm**
pumila L. **Dwarf Elm**

CANNABINACEAE (HEMP FAMILY)

Cannabis sativa L. **Marijuana, Hemp**
Humulus lupulus L. **Common Hop**

URTICACEAE (NETTLE FAMILY)

Laportea canadensis (L.) Wedd. **Wood Nettle**
Parietaria pensylvanica Muhl. **American Pellitory**
Urtica dioica L. **Stinging Nettle**
urens L. **Burning Nettle, Dog Nettle**

SANTALACEAE (SANDALWOOD FAMILY)

Comandra umbellata (L.) Nutt. **Bastard Toadflax**
Geocaulon lividum (Richards.) **Northern Comandra**

LORANTHACEAE (MISTLETOE FAMILY)

Arceuthobium americanum Nutt. **Pine or American Mistletoe**
pusillum Peck **Dwarf Mistletoe**

ARISTOLOCHIACEAE (BIRTHWORT FAMILY)

Asarum canadense L. **Wild Ginger**

POLYGONACEAE (BUCKWHEAT FAMILY)

Eriogonum flavum Nutt. **Yellow Eriogonum, Yellow Umbrellaplant**
Fagopyrum sagittatum Gilib. **Buckwheat**
tataricum (L.) Gaertn. **India-wheat, Tartary Buckwheat**
Koenigia islandica L. **Macounastrum**
Polygonum achoreum Blake
amphibium L. **Water Smartweed, Swamp Persicaria**
arenastrum Jord.
boreale (Lange) **Small Northern Doorweed**
cilinode Michx. **Fringed Black Bindweed, Bindweed**
coccineum Muhl. **Water Smartweed**
convolvulus L. **Black Bindweed, Wild Buckwheat**
cuspidatum Sieb. & Zucc. **Japanese Knotweed, Fleece flower**
douglasii Greene **Douglas Knotweed**
erectum L. **Erect Knotweed**
hydropiper L. **Common Smartweed, Water-pepper**
lapathifolium L. **Willow-weed, Pale Persicaria**
pensylvanicum L. **Pinkweed**
persicaria L. **Lady's-Thumb**
prolificum (Small) Robinson. **Proliferous Knotweed**
punctatum Ell. **Water Smartweed**
ramosissimum Michx. **Bushy Knotweed**
sagittatum L. **Arrow-leaved Tear-thumb**
scabrum Moench **Green Smartweed**
scandens L. **Climbing False Buckwheat**
viviparum L. **Bistort, Alpine Bistort**
Rheum rhaponticum L. **Rhubarb**
Rumex acetosella L. **Sheep Sorrel**
acetosa L. **Garden-Sorrel, Sour Dock**
arcticus Trautv.
crispus L. **Yellow Dock, Curled Dock**
maritimus L. **Golden Dock**
longifolius DC. **Long-leaved Dock**
occidentalis Wats. **Western Dock**
orbiculatus Gray **Water Dock, Great Water Dock**
pseudonatronatus Borbas
salicifolius Weinm **Narrow-leaved Dock**
stenophyllus Ledeb **Narrow-leaved Field Dock**
venosus Pursh **Winged, Sand or Veined Dock, Sour Greens**

CHENOPODIACEAE (GOOSEFOOT FAMILY)

Atriplex argentea Nutt. **Saltbush, Silvery Atriplex**
glabriuscula Edmonston
hortensis L. **Garden Orach, Garden Atriplex**
nuttallii Wats. **Moundscale, Nuttall's Atriplex**
patula L. **Spearscale, Orache**
Axyris amaranthoides L. **Russian Pigweed**
Chenopodium album L. **Pigweed, Lamb's-Quarters**
berlandieri Moq.
capitatum (L.) Asch. **Strawberry Blite**
fremontii Wats. **Fremont's Goosefoot**
glaucum L. **Oak-leaved Goosefoot, Saline Goosefoot**
hybridum L. **Maple-leaved Goosefoot**
leptophyllum (Moq.) Wats. **Narrow-leaved Goosefoot**
rubrum L. Coast-Blite. **Red Goosefoot**
strictum Roth
Corispermum hyssopifolium L. **Bugseed**
nitidum Kit.
Cycloloma atriplicifolium (Spreng.) Coult. **Winged Pigweed**
Eurotia lanata (Pursh) Moq. **White Sage, Winter Sage, Winterfat**
Kochia scoparia (L.) Schrad. **Summer-cypress**
Monolepis nuttalliana (R. & S.) Greene **Poverty-weed**
Salicornia borealis Wolff & Jeffries
europaea L. **Slender or Jointed Glasswort**
rubra Nels. **Samphire, Chickenclaws, Glasswort**
Salsola kali L. **Russian Thistle**
Spinacia oleracea L. **Spinach**
Suaeda maritima (L.) Dumort **Sea-Blite**

AMARANTHACEAE (AMARANTH FAMILY)

Amaranthus albus L. **Tumbleweed**
graecizans L. **Tumbleweed, Prostrate Amaranth**
hybridus L. **Green Amaranth, Pigweed**
retroflexus L. **Green Amaranth, Red-footed Pigweed**
spinosus L. **Thorny Amaranth**

NYCTAGINACEAE (FOUR-O'CLOCK FAMILY)

Mirabilis hirsuta (Pursh) MacM. **Hairy Umbrellawort**
nyctaginea (Michx.) MacM. **Heart-leaved Umbrellawort**

AIZOACEAE (CARPETWEED FAMILY)

Mollugo verticillata L. **Carpetweed**

PORTULACACEAE (PURSLANE FAMILY)

Montia fontana L. **Water-Blinks**
parvifolia (Moc.) Greene
Portulaca oleracea L. **Common Purslane, Purslane**

***CARYOPHYLLACEAE* (PINK FAMILY)**

Agrostemma githago L. **Purple Cockle**
Arenaria humifusa Wahl.
lateriflora L. **Grove-Sandwort, Blunt-leaved Sandwort**
macrophylla Hook **Large-leaved Sandwort**
peploides L. **Seabeach-Sandwort, Sea-purslane**
rossii R. Br.
rubella (Wahl.) Sm.
stricta Michx. **Dawson Sandwort**
Cerastium alpinum L. **Alpine Chickweed**
arcticum Lange
arvense L. **Field Chickweed**
nutans Raf. **Long-stalked Chickweed**
tomentosum L. **Dusty Miller, Snow-in-summer**
vulgatum L. **Common Mouse-eared Chickweed**
Dianthus barbatus L. **Sweet William**
deltoides L. **Steppen Pink**
sylvestris Wulfen **Wood Pink**
Gypsophila paniculata L. **Baby's-breath**
Lychnis alba Mill. **White Cockle**
apetala L. **Nodding Cockle**
chalcedonia L. **Scarlet Lychnis, Maltese-cross**
drummondii Wats. **Drummond's Cockle**
furcata (Raf.) Fern. **Mountain Cockle**
Sagina nivalis (Lindbl.) Fries
nodosa (L.) Fenzl **Pearlwort**
Saponaria officinalis L. **Bouncing-Bet, Soapwort**
vaccaria L. **Cow-Cockle**
Silene antirrhina L. **Sleepy Catchfly**
cserei Baumg. **Smooth Catchfly**
cucubalus Wibel **Bladder-Campion**
menziesii Hook. **Menzies Catchfly**
noctiflora L. **Night-flowering Catchfly**
Spergularia marina (L.) Griseb. **Salt-marsh Sand Spurrey**
Stellaria calycantha (Ledeb.) Bongard **Northern Stitchwort**
crassifolia Ehrh. **Fleshy Stitchwort**
graminea L. **Common Stitchwort**
humifusa Rottb.
longifolia Muhl. **Long-leaved Stitchwort**
longipes Goldie **Long-stalked Stitchwort**
media (L.) Cyrillo **Common Chickweed**

***CERATOPHYLLACEAE* (HORNWORT FAMILY)**

Ceratophyllum demersum L. **Hornwort**

***NYMPHAEACEAE* (WATER-LILY FAMILY)**

Brasenia schreberi Gmel. **Water-shield, Purple Wen-dock**
Nuphar microphyllum (Pers.) Fern. **Small Pond-lily**
variegatum Engelm. **Bullhead-lily, Yellow Pond-lily**
Nymphaea odorata Ait. **Fragrant Water-lily**
tetragona Georgi **Small Water-lily**

***RANUNCULACEAE* (CROWFOOT FAMILY)**

Actaea rubra (Ait.) Willd. **Red Baneberry, Snakeberry**
Adonis annua L. **Pheasant's-eye**
Anemone canadensis L. **Canada Anemone**
cylindrica Gray **Thimbleweed, Long-fruited Anemone**
multifida Poir. **Cut-leaved Anemone**
parviflora Michx. **Small Wood Anemone**
patens L. **Pasque-flower, Prairie-smoke, Crocus Anemone**
quinquefolia L. **Wood-Anemone**
richardsonii Hook **Yellow Anemone**
riparia Fern **Thimbleweed**
Aquilegia brevistyla Hook. **Small-flowered Columbine**
canadensis L. **Wild Columbine**
Caltha natans Pall. **Floating Marsh-marigold**
palustris L. **Marsh-marigold**
Clematis dioscoreifolia Levl & Van
ligusticifolia Nutt **Western or White Virgin's-bower**
virginiana L. **Virgin's-bower**
Coptis trifolia (L.) Salisb. **Goldthread**
Delphinium ajacis L. **Rocket-Larkspur**
virescens Nutt.
Hepatica americana (DC.) Ker
Myosurus minimus L. **Least Mousetail**
Ranunculus acris L. **Common or Tall Buttercup**
aquatilis L. **White Water or Large-leaved Water Crowfoot**
abortivus L. **Kidneyleaf Buttercup**
circinatus Sibth.
cymbalaria Pursh **Seaside Crowfoot, Seaside Buttercup**
fascicularis Muhl. **Early Buttercup**
flabellaris Raf. **Yellow Water Crowfoot**
gmelinii DC. **Small Yellow Water Crowfoot**
hyperboreus Rottb. **Boreal Buttercup**
lapponicus L. **Lapland Buttercup**
macounii Britt. **Macoun's Buttercup**
pallasii Schlecht. **Palias Buttercup**
pedatifidus Sm. **Northern Buttercup**
pensylvanicus L. f. **Bristly Crowfoot, Bristly Buttercup**
repens L. **Creeping Buttercup**
reptans L. **Creeping Spearwort**
rhomboideus Goldie **Prairie Buttercup**
sceleratus L. **Cursed Crowfoot, Celery-leaved Buttercup**
septentrionalis Poir. **Swamp Buttercup**
Thalictrum dasycarpum Fisch. & Lall. **Tall or Purple Meadow-Rue**
revolutum DC.
sparsiflorum Turcz. **Few-flowered Meadow-Rue**
venulosum Trel. **Veiny Meadow-Rue**

***BERBERIDACEAE* (BARBERRY FAMILY)**

Berberis vulgaris L. **Common Barberry**
Caulophyllum thalictroides (L.) Michx. **Papoose-root, Blue Cohosh**

***MENISPERMACEAE* (MOONSEED FAMILY)**

Menispermum canadense L. **Yellow Parilla**

***PAPAVERACEAE* (POPPY FAMILY)**

Argemone mexicana L. **Mexican Prickly or Thorn Poppy**
Eschscholzia californica Cham. **California Poppy**
Papaver rhoeas L. **Corn Poppy**
somniferum L. **Common Poppy, Opium Poppy**
Sanguinaria canadensis L. **Blood-root, Sand-dragon, Sanguinaire, Red Puccoon**

***FUMARIACEAE* (FUMITORY FAMILY)**

Adlumia fungosa (Ait.) Greene **Climbing Fumitory, Mountain-fringe**
Corydalis aurea Willd. **Golden Corydalis**
sempervirens (L.) Pers. **Pink or Pale Corydalis, Rock Harlequin**
Dicentra cucullaria (L.) Bernh. **Dutchman's-breeches**
Fumaria officinalis L. **Common Fumitory, Earth-smoke**

***CAPPARIDACEAE* (CAPER FAMILY)**

Cleome serrulata Pursh **Stinking-clover, Spiderflower, Pink Cleome**
Polanisia dodecandra (L.) DC. **Clammyweed**

***CRUCIFERAE* (MUSTARD FAMILY)**

Alyssum desertorum Stapf
Arabidopsis thaliana (Pall.) Busch
Arabis alpina L. **Alpine Rock-grass, Snow Drift**
arenicola (Richards.) Gelert **Arctic Rock Cress**
divaricarpa Nels. **Purple Rock Cress**
drummondii Gray **Drummond's Rock Cress**
glabra (L.) Bernh. **Tower Mustard**
hirsuta (L.) Scop. **Hirsute Rock Cress**
holboellii Hornem **Holboell's Rock Cress**
lyrata L. **Lyre-leaved Rock Cress**
Armoracia rusticana (Lam.) Gaertn., Mey., & Scherb. **Horse-radish**
Barbarea orthoceras Ledeb. **Winter Cress, American Winter Cress**
vulgaris R.Br. **Yellow-Rocket, Common Winter Cress**
Berteroa incana (L.) DC. **Hoary Alyssum**
Brassica hirta Moench **White Mustard**
juncea (L.) Coss. **Indian, Chinese or Leaf-Mustard**
kaber (DC.) L.C. Wheeler **Charlock, Wild Mustard**
napus L. **Turnip, Winter Rape**
rapa L. **Bird's Rape**
Braya humilis (C.A. Meyer) Robinson
Camelina microcarpa Andrz. **Small-seeded False Flax**
parandii Ibarra & La Porte
sativa (L.) Crantz **False Flax**
Capsella bursa-pastoris (L.) Medic. **Shepherd's-purse**
Cardamine bulbosa (Schreb.) BSP **Spring Cress**
parviflora L. **Small Bitter Cress**
pensylvanica Muhl. **Bitter Cress**
pratensis L. **Cuckoo-flower, Meadow Bitter Cress**
Cardaria draba (L.) Desv. **Hoary Cress, Heart-podded Hoary Cress**
pubescens (Mey.) **Whitetop, Globe-podded Hoary Cress**
Cochlearia officinalis L. **Scurvy-grass**
Conringia orientalis (L.) Dumort. **Hare's-ear Mustard**
Descurainia pinnata (Walt.) Britt. **Short-fruited Tansy Mustard**
richardsonii (Sweet) O.E. Schulz **Gray Tansy Mustard**
sophia (L.) Webb **Flixweed**
sophioides (Fisch.) **Northern Flixweed**
Diplotaxis muralis (L.) DC. **Wall- or Sand- rocket, Mustard, Stinkweed**
Draba alpina L. **Alpine Whitlow-grass**
aurea Vahl. **Golden Whitlow-grass**
cinerea Adams
fladnizensis Wulf.
glabella Pursh
incana L.
nemorosa L. **Yellow Whitlow-grass**
nivalis Liljebl. **Yellow Arctic Whitlow-grass**
reptans (Lam.) Fern. **Creeping Whitlow-grass**
Eruca sativa Mill. **Garden-Rocket**
Erucastrum gallicum (Willd.) O.E. Schulz **Dog Mustard**
Erysimum asperum (Nutt.) DC. **Western Wallflower, Prairie-Rocket**
cheiranthoides L. **Wormseed Mustard**
inconspicuum (Wats.) MacM. **Small-flowered Prairie-Rocket**
Eutrema edwardsii R.Br.
Hesperis matronalis L. **Dame's-Violet**
Hutchinsia procumbens (L.) Desv. **Prostrate Hutchinsia**
Lepidium densiflorum Schrad. **Common Pepper-grass**
ramosissimum Nels. **Branched Pepper-grass**
ruderale L. **Roadside Pepper-grass**
sativum L. **Garden Cress**
Lesquerella arctica (Wormsk.) Wats. **Northern Bladderpod**
ludoviciana (Nutt.) Wats. **Sand Bladderpod**
Lunaria annua L. **Honesty**
Nasturtium officinale R.Br. **True Watercress**
Neslia paniculata (L.) Desv. **Ball Mustard**
Raphanus sativus L. **Radish**
Rorippa austriaca (Crantz) Bess. **Austrian Field Cress, Austrian Cress**
islandica (Oeder) Borbas **Marsh Yellow Cress**
sylvestris (L.) Bess. **Creeping Yellow Cress**
Sisymbrium altissimum L. **Tumbling Mustard**
loeselii L. **Tall Hedge Mustard**
officinale (L.) Scop. **Hedge Mustard**
Subularia aquatica L. **Water Awl-wort**
Thlaspi arvense L. **Frenchweed, Field Pennycress, Stinkweed**

***RESEDACEAE* (MIGNONETTE FAMILY)**

Reseda alba L. **White or White Cut-leaved Mignonette**
lutea L. **Yellow or Yellow Cut-leaved Mignonette**

***SARRACENIACEAE* (PITCHER-PLANT FAMILY)**

Sarracenia purpurea L. **Pitcher Plant**

***DROSERACEAE* (SUNDEW FAMILY)**

Drosera anglica Huds. **Oblong-leaved Sundew**
linearis Goldie **Slender-leaved Sundew**
rotundifolia L. **Round-leaved Sundew**

***CRASSULACEAE* (ORPINE FAMILY)**

Penthorum sedoides L. **Ditch-Stonecrop**
Sedum acre L. **Mossy Stonecrop, Wallpepper, Mountain Moss**
hybridum L.
telephium L. **Stonecrop**

***SAXIFRAGACEAE* (SAXIFRAGE FAMILY)**

Chrysosplenium alternifolium L. **Golden Saxifrage**
Heuchera richardsonii R. Br. **Alumroot**
Mitella nuda L. **Miterwort, Bishop's-cap**
Parnassia glauca Raf. **Glaucous grass-of-Parnassus**
kotzebuei Cham. **Small grass-of-Parnassus**
palustris L. **Northern grass-of-Parnassus**
parviflora DC.
Ribes americanum Mill. **Wild Black Currant**
diacanthum Pallas **Siberian Currant**
glandulosum Grauer **Skunk Currant, Skunkberry**
hudsonianum Richards. **Northern Black Currant**
lacustre (Pers.) Poir. **Bristly Black Currant, Swamp Gooseberry**
oxyacanthoides L. **Northern or Canada Gooseberry**
sylvestre (Lam.) Mert. & Koch **European Red Currant**
triste Pall. **Red Currant**
Saxifraga aizoides L. **Yellow Mountain Saxifrage**
caespitosa L.
cernua L. **Nodding or Drooping Bulbous Saxifrage**
hirculus L.
oppositifolia L. **Purple Mountain-Saxifrage, Red-flowered Saxifrage**
pensylvanica L. **Swamp Saxifrage, Wild-beet, Marsh Saxifrage**
rivularis L. **Alpine Brook Saxifrage**
tricuspidata Rottb. **Three-toothed Saxifrage**
virginensis Michx. **Early Saxifrage**

***ROSACEAE* (ROSE FAMILY)**

Agrimonia gryposepala Wallr. **Tall Hairy Agrimony**
striata Michx. **Agrimony**
Amelanchier alnifolia Nutt. **Saskatoon-berry, Saskatoon**
macrocarpa Nielsen
sanguinea (Pursh) DC. **Round-leaved June-berry**
wiegandii Nutt.
Chamaerhodos erecta (L.) **Bunge Chamaerhodos**
Cotoneaster acutifolia Turcz. **Cotoneaster**
melanocarpa Lodd. **Cotoneaster**
Crataegus rotundifolia Moench **Round-leaved Hawthorn**
succulenta Link **Long-spined Hawthorn**
Dryas integrifolia Vahl **White Mountain-avens**
Fragaria vesca L. **American Wild or Woodland Strawberry**
virginiana Duchesne **Smooth Wild Strawberry**
Geum aleppicum Jacq. **Yellow Avens**
macrophyllum Willd. **Large-leaved Avens**
rivale L. **Water Avens, Purple Avens**
triflorum Pursh **Three-flowered Avens, Torchflower, Prairie Smoke**
Potentilla anserina L. **Silverweed**
argentea L. **Silvery Cinquefoil**
arguta Pursh **White or Tall Cinquefoil**
concinna Richardson **Early Cinquefoil**
egedii Wormsk.
finitima Kohli & Packer
fruticosa L. **Shrubby Cinquefoil**
gracilis Dougl. **Graceful Cinquefoil**
hippiana Lehm. **Woolly Cinquefoil**
hyparctica Malte
multifida L. **Branched Cinquefoil**
nivea L. **Snow Cinquefoil**
norvegica L. **Rough Cinquefoil**
palustris (L.) Scop. **Marsh Five-finger, Marsh Cinquefoil**
paradoxa Nutt. **Bushy Cinquefoil**
pensylvanica L. **Prairie Cinquefoil**
plattensis Nutt. **Low Cinquefoil**
pulchella R. Br.
recta L. **Rough-fruited Cinquefoil**
rivalis Nutt. **Brook Cinquefoil**
tridentata Ait. **Three-toothed Cinquefoil**
Prunus americana Marsh. **American Plum**
nigra Ait. **Canada Plum**
pensylvanica L.f. **Pin Cherry**
pumila L. **Sand Cherry, Low Sand Cherry**
virginiana L. **Choke Cherry, Red fruited Choke Cherry**
Pyrus malus L. **Apple**
Rosa acicularis Lindl. **Prickly Rose**
arkansana Porter **Low Prairie Rose**
blanda Ait. **Smooth Rose**
woodsii Lindl. **Wood's Rose**
Rubus acaulis Michx. **Stemless Raspberry**
chamaemorus L. **Baked-apple-berry, Cloudberry**
idaeus L. **Raspberry, Wild Red Raspberry**
paracaulis Bailey,
pubescens Raf. **Dewberry**
Sorbus decora (Sarg.) Schneid **Mountain-Ash**
Spiraea alba Du Roi Meadowsweet, **Narrow-leaved Meadowsweet**

***LEGUMINOSAE* (PULSE FAMILY)**

Amorpha canescens Pursh **Leadplant**
fruticosa L. **False Indigo**
nana Nutt. **Fragrant False Indigo, Dwarf False Indigo**
Amphicarpa bracteata (L.) Fern. **Hog-Peanut**
Anthyllis vulneraria L.
Astragalus aboriginum Richardson **Indian Milkvetch**
adsurgens Pallas **Ascending Milkvetch**
agrestis Dougl.
alpinus L. **Alpine Milkvetch**
americanus (Hook.) M.E. Jones
bisulcatus (Hook.) Gray **Two-grooved Milkvetch**
bodinii Sheldon
canadensis L. **Canadian Milkvetch**
cicer L. Cicer **Milkvetch**
crassicarpus Nutt. **Ground-plum**
eucosmus Robins. **Pretty Milkvetch**
flexuosus Dougl. **Slender or Low Milkvetch**
gilviflorus Sheldon **Cushion Milkvetch**
lotiflorus Hook. **Low Milkvetch**
missouriensis Nutt. **Missouri Milkvetch**
neglectus (T. & G.) Sheldon
pectinatus Dougl. **Narrow-leaved Milkvetch**
tenellus Pursh **Loose-flowered Milkvetch**
Caragana arborescens Lam. **Siberian Pea-shrub, Common Caragana**
Cicer arietinum L. **Chick-pea**
Coronilla varia L. **Field Crown-Vetch**
Desmodium canadense (L.) DC. **Beggar's-lice**
Glycyrrhiza lepidota (Nutt.) Pursh **Wild Licorice**
Hedysarum alpinum L.
boreale Nutt. **Northern Hedysarum**
Lathyrus japonicus Willd. **Beach-Pea**
ochroleucus Hook. **Pale Vetchling, Cream-colored Vetchling**
palustris L. **Vetchling, Marsh Vetchling**
tuberosus L. **Tuberous Vetchling**
venosus Muhl. **Wild Peavine**
Lotus corniculatus (L.) **Bird's-foot-Trefoil**
purshianus (Benth.) Clem. & Clem. **Prairie-Trefoil**
Medicago falcata L. **Yellow Lucerne**
lupulina L. **Black Medick**
sativa L. **Alfalfa, Lucerne**
Melilotus alba Desr. **White Sweet Clover**
indica (L.) All. **Annual Yellow Sweet Clover, Yellow Sweet Clover**
officinalis (L.) Pallas **Yellow Sweet Clover**
Onobrychis viciifolia Scop. Sainfoin, **Holy Clover**
Oxytropis arctica R.Br. **Arctic Oxytrope**
campestris (L.) DC. **Late Yellow Locoweed**
deflexa (Pall.) DC. **Reflexed Locoweed**
lambertii Pursh **Purple Locoweed**
leucantha (Pall.) Pers
sericea Nutt. **Early Yellow Locoweed**
splendens Dougl. **Showy Locoweed**
Petalostemum candidum (Willd.) Michx. **White Prairie-Clover**
purpureum (Vent.) Rydb. **Purple Prairie-Clover**
villosum Nutt. **Silky Prairie-Clover**
Psoralea argophylla Pursh **Silverleaf Psoralea, Silverweed**
esculenta Pursh Breadroot, **Indian Breadroot**
Thermopsis rhombifolia (Nutt.) Richards. **Golden Bean**
Trifolium hybridum L. **Alsike Clover**
pratense L. **Red Clover**
procumbens L. **Low Hop-clover**
repens L. **White Clover**
Trigonella caerulea (L.) Ser.
Vicia americana Muhl. **Common Vetch**
cracca L. **Tufted Vetch, Canada-pea**
sativa L. **Spring-Vetch, Vetch**
villosa Roth **Hairy Vetch, Winter Vetch**

***LINACEAE* (FLAX FAMILY)**

Linum perenne Pursh **Blue Flax**
perenne L. **Perennial Flax**
rigidum Pursh **Yellow Flax, Large-flowered Yellow Flax**
sulcatum Riddell **Yellow Flax, Grooved Yellow Flax**
usitatissimum L. **Common Blue Flax**

***OXALIDACEAE* (WOOD-SORREL FAMILY)**

Oxalis dillenii Jacq.
stricta L. **Yellow Wood-sorrel**

***GERANIACEAE* (GERANIUM FAMILY)**

Erodium cicutarium (L.) L'Her. **Alfilaria, Filaria, Pin-Clover**
Geranium bicknellii Britt. **Bicknell's Geranium**
carolinianum L. **Carolina Wild Geranium**
pratense L. **Meadow Geranium**
pusillum L. **Small-flowered Crane's-bill**

***POLYGALACEAE* (MILKWORT FAMILY)**

Polygala paucifolia Willd. **Fringed Polygala, Fringed Milkwort**
senega L. **Seneca Snakeroot**
verticillata L. **Whorled Milkwort**

***EUPHORBIACEAE* (SPURGE FAMILY)**

Euphorbia cyparissias L. **Cypress Spurge**
esula L. **Leafy Spurge, Wolf's-milk**
geyeri Engelm. **Prostrate Spurge**
glyptosperma Engelm. **Ridge-seeded Spurge**
marginata Pursh **Snow-on-the-mountain**
peplus L. **Petty Spurge**
serpyllifolia Pers. **Thyme-leaved Spurge**

***CALLITRICHACEAE* (WATER-STARWORT FAMILY)**

Callitriche anceps Fern. **Vernal Water-starwort**
hermaphroditica L. **Northern Water-starwort**
heterophylla Pursh **Larger Water-starwort**
verna L. **Vernal Water-starwort**

***EMPETRACEAE* (CROWBERRY FAMILY)**

Empetrum nigrum L. **Black Crowberry, Curlewberry**

***ANACARDIACEAE* (CASHEW FAMILY)**

Rhus glabra L. **Smooth Sumac**
radicans L. **Poison-Ivy**

***CELASTRACEAE* (STAFF-TREE FAMILY)**

Celastrus scandens L. **Climbing Bittersweet, Bittersweet**

***ACERACEAE* (MAPLE FAMILY)**

Acer negundo L. **Manitoba Maple Box Elder, Ash-leaf Maple**
spicatum Lam. **White or Mountain Maple**

***BALSAMINACEAE* (TOUCH-ME-NOT-FAMILY)**

Impatiens capensis Meerb. **Spotted Touch-me-not, Jewelweed, Snapweed**
sub-tangere L. **Western Jewelweed**

***RHAMNACEAE* (BUCKTHORN FAMILY)**

Ceanothus herbaceus Raf **Redroot, New Jersey Tea**
Rhamnus alnifolia L'Her. **Alder-leaved Buckthorn**
cathartica L. **Common Buckthorn, Buckthorn**
frangula L. **Alder-Buckthorn, Black Alder**

VITACEAE (VINE FAMILY)

Parthenocissus quinquefolia (L.) Planch. **Virginia Creeper**
inserta (Kerner) K. Fritsch **Large-toothed Virginia Creeper**
Vitis riparia Michx. **Riverbank Grape**

TILIACEAE (LINDEN FAMILY)

Tilia americana L. **Basswood. Whitewood**

MALVACEAE (MALLOW FAMILY)

Abutilon theophrasti Medic. **Velvet-leaf**
Althaea rosea Cav. **Hollyhock**
Hibiscus trionum L. **Flower-of-an-hour**
Lavatera thuringiaca L.
Malva moschata L. **Musk Mallow**
neglecta Wallr. **Common Mallow**
pusilla Sm. **Low, Dwarf or Running Mallow**
verticillata L. **Curled Mallow**
Sphaeralcea coccinea (Pursh) Rydb. **Scarlet Mallow**

HYPERICACEAE (ST. JOHN'S-WORT FAMILY)

Hypericum canadense L. **Canada St. John's-wort**
majus (Gray) Britt. **Large Canada St. John's-wort**
mutilum L. **Dwarf, Small-flowered or Slender St. John's-wort**
virginicum L. **Marsh St. John's-wort**

ELATINACEAE (WATERWORT FAMILY)

Elatine triandra Schkuhr **Mud-purslane**

CISTACEAE (ROCKROSE FAMILY)

Helianthemum bicknellii Fern. **Frostweed**
Hudsonia tomentosa Nutt. **Beach-heath. False Heather. Sand Heather**
Lechea intermedia Leggett **Pinweed**

VIOLACEAE (VIOLET FAMILY)

Viola adunca Sm. **Early Blue Violet**
arvensis Murr. **Wild Pansy**
blanda Willd. **Sweet White Violet**
canadensis L. **Canada Violet**
conspersa Reichenb. **American Dog Violet**
epipsila Ledeb.
eriocarpa Schwein **Smooth Yellow Violet**
macloskeyi Lloyd
nephrophylla Greene **Northern Bog Violet**
novae-angliae House **New England Blue Violet**
nuttallii Pursh **Yellow Prairie-Violet**
palustris L. **Alpine March or Marsh Violet**
pedatifida G. Don **Larkspur, Purple Prairie or Crowfoot Violet**
pubescens Ait. **Downy Yellow Violet**
renifolia Gray **Kidney-shaped Violet**
selkirkii Pursh **Long-spurred Violet**
sororia Willd. **Woolly Blue Violet**
tricolor L. **Pansy. Lady's Delight**

LOASACEAE (LOASA FAMILY)

Mentzelia decapetala (Pursh) Urban & Gilg **Stickleaf. Gumbo-Lily. Eveningstar**

CACTACEAE (CACTUS FAMILY)

Coryphantha vivipara (Nutt.) Britt. & Brown **Pincushion Cactus**
Opuntia fragilis (Nutt.) Haw. **Brittle Prickly-pear**

ELEAGNACEAE (OLEASTER FAMILY)

Elaeagnus angustifolia L. **Russian-Olive. Oleaster**
commutata Bernh. **Silverberry. Wolf-willow**
Shepherdia argentea Nutt. **Buffaloberry**
canadensis (L.) Nutt. **Soapberry. Canada Buffaloberry**

LYTHRACEAE (LOOSESTRIFE FAMILY)

Lythrum salicaria L. **Purple or Spiked Loosestrife**

ONAGRACEAE (EVENING-PRIMROSE FAMILY)

Circaea alpina L. **Small Enchanter's-nightshade**
quadrisulcata (Max.) Pomk. & Sav. **Large Enchanter's-nightshade**
Epilobium angustifolium L. **Fireweed. Great Willowherb**
latifolium L. **River-beauty. Broad-leaved Fireweed**
leptophyllum Raf.
palustre L. **Marsh Willow-Herb**
paniculatum Nutt. **Annual Willow-herb**
watsonii Barbey **Northern Willow-herb**
Gaura coccinea Pursh **Scarlet Gaura**
Oenothera biennis L. **Evening-Primrose. Yellow Evening-Primrose**
nuttallii Sweet **White Evening-Primrose**
parviflora L. **Evening-Primrose**
perennis L. **Sundrops**
serrulata Nutt.

HALORAGACEAE (WATER-MILFOIL FAMILY)

Myriophyllum alterniflorum DC. **Water-milfoil**
spicatum L. **Spiked Water-milfoil**

HIPPURIDACEAE (MARE'S-TAIL FAMILY)

Hippuris tetraphylla L.f. **Four-leaved Mare's-tail**
vulgaris L. **Mare's-tail**

ARALIACEAE (GINSENG FAMILY)

Aralia hispida Vent. **Bristly Sarsaparilla**
nudicaulis L. **Wild Sarsaparilla**
racemosa L. **Spikenard**

UMBELLIFERAE (PARSLEY FAMILY)

Aegopodium podagraria L. **Goutweed**
Anethum graveolens L. **Dillweed. Dill**
Carum carvi L. **Caraway. Anis**
Cicuta bulbifera L. **Bulb-bearing Water-hemlock**
maculata L. **Spotted Cowbane. Musquash-root. Water-hemlock**
Conioselinum canadense (L.) DC. **Wild Chevril. Hemlock**
Cymopterus acaulis (Pursh) Raf. **Plains Cymopteris**
Daucus carota L. **Wild Carrot. Queen Anne's-lace**
Heracleum lanatum Michx. **Cow-parsnip**
Lomatium foeniculaceum (Nutt.) C. & R.
macrocarpum (H. & A.) C.& R. **Long-fruited Parsley**
orientale C. & R. **White-flowered Parsley**
Musineon divaricatum (Pursh) Nutt. **Leafy Musineon**
Osmorhiza chilensis (Miche.) Clarke **Wooly or Hairy Sweet-cicely**
depauperata Phil.
longistylis (Torr.) DC. **Anise-root**
Pastinaca sativa L. **Parsnip. Wild Parsnip**
Sanicula marilandica L. **Snakeroot**
Sium suave Walt. **Water-parsnip**
Zizia aptera (Gray) Fern. **Heart-leaved Alexanders**
aurea (L.) W.D.J. Koch **Golden Alexanders**

CORNACEAE (DOGWOOD FAMILY)

Cornus alternifolia L.f. **Green Osier. Pagoda or Alternate-leaved Dogwood**
canadensis L. **Bunchberry**
racemosa Lam. **Panicled or Gray Dogwood**
rugosa Lam. **Round-leaved or Spotted Dogwood**
stolonifera Michx. **Red Osier**

PYROLACEAE (WINTERGREEN FAMILY)

Chimaphila umbellata (L.) Bart. **Prince's-pine. Pipsissewa**
Hypopitys monotropa Crantz **Pinesap. False Beech-drops**
Moneses uniflora (L.) Gray **One-flowered pyrola. One-flowered Pyrola**
Monotropa uniflora L. **Indian-pipe**
Pyrola asarifolia Michx. **Pink Pyrola. Wintergreen**
elliptica Nutt. **Shinleaf. Common Shinleaf**
grandiflora Radius **Arctic Pyrola. Wintergreen**
minor L. **Lesser Wintergreen**
rotundifolia L. **Common Wintergreen**
secunda L. **One-sided Pyrola. One-sided Wintergreen**
virens Schweigg. **Greenish-flowered Wintergreen**

ERICACEAE (HEATH FAMILY)

Andromeda glaucophylla Link **Bog-Rosemary**
polifolia L. **Wild Rosemary, Marsh Holy Rose**
Arctostaphylos alpina (L.) Spreng. **Alpine Bearberry**
rubra (Rehd. & Wils.) Fern.
uva-ursi (L.) Spreng. **Common Bearberry. Bearberry**
Cassiope tetragona (L.) D.Don **White Mountain- or Arctic White Heather**
Chamaedaphne calyculata (L.) Moench **Leatherleaf. Cassandra**
Epigaea repens L. Mayflower. **Trailing Arbutus**
Gaultheria hispidula (L.) Bigel. **Creeping Snowberry**
procumbens L. **Teaberry. Checkerberry**
Kalmia polifolia Wang. **Pale-, Swamp- or Bog-Laurel**
Ledum groenlandicum Oeder **Trapper's-tea**
palustre L. **Labrador-tea**
Loiseleuria procumbens (L.) Desv. **Alpine Azalea**
Oxycoccus microcarpus Turcz. **Small Cranberry**
quadripetalus Gilib. **Small Cranberry**
Phyllodoce caerulea (L.) Bab. **Purple Mountain-Heather**
Rhododendron lapponicum (L.) Wahl. **Lapland Rose-bay**
Vaccinium angustifolium Ait. **Low Sweet-Blueberry. Blueberry**
caespitosum Michx. **Dwarf Bilberry**
myrtilloides Michx. **Sour-top-Blueberry. Velvet-leaf-Blueberry**
uliginosum L. **Alpine Bilberry. Bog Whortleberry**
vitis-idaea L. **Rock- or Dry-ground Cranberry**

DIAPENSIACEAE (DIAPENSIA FAMILY)

Diapensia lapponica L. **Northern Diapensia**

PRIMULACEAE (PRIMROSE FAMILY)

Androsace occidentalis Pursh **Western Pygmyflower**
septentrionalis L. **Pygmyflower**
Dodecatheon pauciflorum (Durand.) Greene **Shooting-star**
Glaux maritima L. **Sea-milkwort. Saltwort**
Lysimachia terrestris (L.) BSP. **Yellow Loosestrife. Swamp-candles**
thyrsiflora L **Tufted Loosestrife**
Primula egaliksensis Wormsk. **Greenland Primrose**
incana Jones **Mealy Primrose**
mistassinica Michx. **Bird's-eye-Primrose. Dwarf Primrose**
stricta Hornem. **Erect Primrose**
Steironema ciliatum (L.) Raf. **Fringed Loosestrife**
hybridum (Michx.) Raf. **Lance-leaved Loosestrife**
quadrifolium (Sims) Hitchc. **Whorled Loosestrife**
Trientalis borealis Raf. **Starflower. Northern Starflower**

***PLUMBAGINACEAE* (LEADWORT OR PLUMBAGO FAMILY)**

Armeria maritima (Mill.) Willd.

OLEACEAE (OLIVE FAMILY)

Fraxinus nigra Marsh. **Black Ash**
pennsylvanica Marsh. **Red Ash**

GENTIANACEAE (GENTIAN FAMILY)

Gentiana affinis Griseb. **Oblong-leaved Gentian**
andrewsii Griseb. **Closed Gentian**
linearis Froel. **Closed or Closed Marsh Gentian**
puberulenta Pringle **Downy Gentian**
Gentianella amarella (L.) Borner **Felwort. Northern Gentian**
crinita (Froel.) Don **Fringed Gentian**
propinqua (Richards) Gillett **Felwort**
Halenia deflexa (Sm.) Griseb. **Spurred Gentian**
Lomatogonium rotatum (L.) Fries **Marsh Felwort**
Menyanthes trifoliata L. **Buckbean. Bogbean**

APOCYNACEAE (DOGBANE FAMILY)

Apocynum androsaemifolium L. **Spreading Dogbane**
cannabinum L. **Indian-hemp**

ASCLEPIADACEAE (MILKWEED FAMILY)

Asclepias incarnata L. **Swamp Milkweed**
lanuginosa (Nutt.) Torr. **Hairy Milkweed**
ovalifolia Dcne. **Dwarf Milkweed**
speciosa Torr. **Showy Milkweed**
syriaca L. **Common or Silky Milkweed**
verticillata L. **Whorled Milkweed**
viridiflora Raf. **Green Milkweed**

CONVOLVULACEAE (CONVOLVULUS FAMILY)

Convolvulus arvensis L. **Field Bindweed. Cornbine**
sepium L. **Hedge Bindweed. Wild Morning-glory**
Cuscuta cephalanthi Engelm.
coryli Engelm.
gronovii Willd. **Common Dodder**
pentagona Engelm.
umbrosa Beyrich

POLEMONIACEAE (POLEMONIUM FAMILY)

Collomia linearis Nutt. **Narrow-leaved Collomia**
Phlox hoodii Richards. **Moss Pink**

HYDROPHYLLACEAE (WATERLEAF FAMILY)

Ellisia nyctelea L. **Waterpod**
Hydrophyllum virginianum L. **John's-Cabbage**
Phacelia franklinii (R. Br.) Gray **Franklin's Scorpionweed**
tanacetifolia Benth. **Fiddle-neck. Tansy Scorpionweed**

BORAGINACEAE (BORAGE FAMILY)

Amsinckia menziesii (Lehm.) Nels. & Macbr. **Fiddle-neck**
Asperugo procumbens L. **German Madwort**
Borago officinalis L. **Borage. Oxtongue**
Cynoglossum boreale Fern. **Northern Wild Comfrey. Wild Comfrey**
officinale L. **Common Hound's-tongue**
Echium lycopsis L. **Purple Viper's Bugloss**
vulgare L. **Blueweed. Blue Devil. Viper's Bugloss**
Hackelia deflexa (Wahl.) Opiz **Beggar's Lice**
floribunda (Lehm.) Johnston
Heliotropium curassavicum L. **Spatulate-leaved or Seaside Leave Heliotrope**
Lappula myosotis Moench **European Stickseed**
redowskii (Hornem.) Greene
Lithospermum arvense L. Corn Gromwell
canescens (Michx.) Lehm. **Puccoon. Indian-paint. Hoary Puccoon**
incisum Lehm. **Narrow-leaved Puccoon**
officinale L. **Common Gromwell. Gromwell**
Lycopsis arvensis L. **Bugloss. Small Bugloss**
Mertensia lanceolata (Pursch) A. DC. **Tall Lungwort**
maritima (L.) S.F. Gray **Oysterleaf. Seaside Lungwort**
paniculata (Ait.) G. Don **Tall Lungwort**
Myosotis arvensis (L.) Hill **Field Forget-me-not**
scorpioides L. Marsh **Forget-me-not**
Onosmodium molle Michx **Marble-seed. False or Western False Gromwell**
Plagiobothrys scouleri (H. & A.) Johnston **Scouler's Allocarya**
Symphytum asperum Lepechin **Prickly Comfrey. Rough Comfrey**

VERBENACEAE (VERVAIN FAMILY)

Verbena bracteata Lag. & Rodr. **Bracted Vervain**
hastata L. **Blue Vervain**

LABIATAE (MINT FAMILY)

Agastache foeniculum (Pursh) Kize. **Giant or Blue Giant Hyssop**
Dracocephalum formosius (Lunell) Rydb. **Purple or Western Lion's Heart**
nuttalli Britt.
virginianum L. **Dragon-head, Lion's Heart**
Elsholtzia ciliata (Thunb.) Hylander
Galeopsis tetrahit L. **Common Hemp-nettle. Hemp-nettle**
Glechoma hederacea L. **Gill-over-the-ground. Ground-ivy**
Hedeoma hispida Pursh **Rough Pennyroyal**
Lamium album L. **Snowflake. White Dead-nettle**
amplexicaule L. Henbit
Leonurus cardiaca L. **Common Motherwort. Motherwort**
sibiricus L. **Siberian Motherwort**
Lycopus americanus Muhl. **Water-horehound**
asper Greene **Western Water-horehound**
uniflorus Michx. **Northern Bugle-weed**
Melissa officinalis L. **Common or Honey Balm**
Mentha arvensis L. **Common Mint. Field Mint**
spicata L. **Spearmint**
Moldavica parviflora (Nutt.) Britt. **American Dragon-head**
thymiflora (L.) Rydb.
Monarda fistulosa L. **Wild Bergamot**
Nepeta cataria L. **Catnip**
Prunella virgaunm (L.) Durand & Jackson **Selfheal**
vulgaris L. **Heal-all. Carpenter-weed**
Salvia reflexa Hornem. **Lance-leaved Sage**
sylvestris L.
Scutellaria epilobiifolia Hamilton **Common Skullcap**
lateriflora L. **Mad-dog Skullcap. Blue Skullcap**
Stachys palustris L. **Woundwort. Marsh Hedge-nettle**
tenuifolia Willd. **Smooth Hedge Nettle**
Teucrium occidentale Gray **Hairy Germander**

SOLANACEAE (NIGHTSHADE FAMILY)

Hyoscyamus niger L. **Black Henbane**
Physalis alkekengi L. **Chinese Lantern Plant. Winter-cherry**
grandiflora Hook. **Large White-flowered Ground-cherry**
heterophylla Nees **Yellow Ground-cherry**
ixocarpa Brotero **Tomatillo**
pubescens L. **Small Yellow Ground-cherry**
virginiana Mill. **Prairie Ground-cherry**
Solanum americanum Mill. **Black Nightshade**
dulcamara L. **Bittersweet. Nightshade**
rostratum Dunal **Buffalo-bur**
sarrachoides Sendtner
triflorum Nutt. **Wild Tomato**
tuberosum L. **Potato**

SCROPHULARIACEAE (FIGWORT FAMILY)

Bartsia alpina L. **Velvet Bells. Alpine Bartsia**
Castilleja coccinea (L.) Spreng. **Scarlet Painted-cup. Scarlet Paintbrush**
miniata Dougl. **Red Indian Paintbrush**
pallida (L.) Spreng. **Labrador Paintbrush**
raupii Pennell **Purple Paintbrush**
sessiliflora Pursh. **Downy Painted-cup. Downy Paintbrush**
Chaenorrhinum minus (L.) Lange **Dwarf Snapdragon**
Chelone glabra L. **Turtlehead. Balmony**
Collinsia parviflora Dougl. **Blue-eyed Mary**
Euphrasia arctica Lange **Northern Eyebright**
hudsoniana Fern. & Wieg.
Gerardia aspera Dougl. **Rough Purple Agalinis**
purpurea L. **Large Purple Agalinis**
tenuifolia Vahl **Slender Agalinis**
Gratiola neglecta Torr. **Clammy Hedge-hyssop**
Limosella aquatica L. **Madwort**
Linaria dalmatica (L.) Mill.
vulgaris Hill **Butter-and-eggs. Common or Yellow Toadflax**
Melampyrum lineare Desr. **Cow-wheat**
Mimulus glabratus HBK. **Smooth Monkeyflower**
ringens L. **Blue Monkeyflower**
Odontites verna (Bell.) Dum. **Red Bartsia**
Orthocarpus luteus Nutt. **Owl's-clover**
Pedicularis canadensis L. **Common Lousewort. Wood-betony**
flammea L. **Flame-colored Lousew. rt**
groenlandica Retz. **Elephant's-head**
labradorica Wirsing **Labrador Lousewort**
lanceolata Michx. **Swamp Lousewort**
lapponica L. **Lapland Rattle**
parviflora Sm. **Purple Lousewort**
sudetica Willd. **Purple Rattle**
Penstemon albidus Nutt. **White Beardgrass**
gracilis Nutt. **Lilac-flowered Beardgrass**
nitidus Dougl. **Smooth Blue Beardtongue**
procerus Dougl. **Slender Beardgrass**
Rhinanthes borealis (Sterneck) Chabert
crista-galli L. **Common Yellowrattle**
Verbascum thapsus L. **Common Mullein. Flannel-plant**
Veronica americana (Raf.) Schwein. **American Brooklime. American Speedwell**
catenata Pennell **Water-Speedwell**
longifolia L.
peregrina L. **Neck-weed. Purslane or Hairy Speedwell**
persica Poir. **Bird's-eye**
polita Fries **Smooth Speedwell**
scutellata L. **Marsh Speedwell**
Veronicastrum virginicum (L.) Farwell **Culver's-root**

OROBANCHACEAE (BROOM-RAPE FAMILY)

Conopholis americana (L. Wallr.) **Squawroot. Cancerroot**
Orobanche fasciculata Nutt. **Clustered Broom-rape**
ludoviciana Nutt. **Louisiana Broom-rape**

LENTIBULARIACEAE (BLADDERWORT FAMILY)

Pinguicula villosa L. **Small Butterwort**
vulgaris L. **Common Butterwort. Butterwort**
Utricularia cornuta Michx **Horned Bladderwort**
intermedia Hayne **Flat-leaved Bladderwort**
minor L. **Lesser Bladderwort**
vulgaris L. **Greater Bladderwort**

PHRYMACEAE (LOPSEED FAMILY)

Phryma leptostachya L. **Lopseed**

PLANTAGINACEAE (PLANTAIN FAMILY)

Plantago coronopus L. **Buckhorn Plantain. Crowfoot**
elongata Pursh **Linear-leaved Plantain**
eriopoda Torr. **Saline Plantain**
lanceolata L. **Ribgrass. Ripplegrass. Buckthorn. English Plantain**
major L. **Common Plantain. Whiteman's-foot**
maritima L. **Seaside Plantain. Goose-tongue**
media L. **Hoary Plantain**
patagonica Jacq. **Patagonia. Indian-wheat. Pursh's Plantain**
psyllium L. **Flaxseed or Sand Plantain**

RUBIACEAE (MADDER FAMILY)

Galium aparine L. **Cleavers. Goosegrass**
boreale L. **Northern Bedstraw**
labradoricum Wieg. **Ladies' Bedstraw**
palustre L. **Marsh Bedstraw**
trifidum L. **Small Bedstraw**
triflorum Michx. **Sweet-scented Bedstraw**
verum L. **Yellow Bedstraw. Our Lady's Bedstraw**
Houstonia longifolia Gaertn. **Houstonia. Long-leaved Bluets**

CAPRIFOLIACEAE (HONEYSUCKLE FAMILY)

Diervilla lonicera Mill. **Bush-honeysuckle**
Linnaea borealis L. **Twinflower**
Lonicera dioica L. **Limber or Twining Honeysuckle**
involucrata (Richards.) Banks **Black Twinberry. Involucrate Honeysuckle**
oblongifolia (Goldie) Hook. **Swamp-Fly-Honeysuckle**
tatarica L. **Tartarian Honeysuckle**
villosa (Michx.) **Mountain-Fly-Honeysuckle**
Sambucus canadensis L. **Commmon Elder**
racemosa L. **Red-berried Elder. Stinking Elder. Red Elderberry**
Symphoricarpos albus (L.) **Blake Snowberry**
occidentalis Hook. **Wolfberry. Buckbrush. Western Snowberry**

Viburnum edule (Michx.) Raf. **Pimbina. Mooseberry. Lowbush-cranberry**
lentago L. **Sheepberry. Nannyberry**
opulus L. **Highbush-cranberry**
rafinesquianum Schultes **Downy Arrow-wood**

ADOXACEAE (MOSCHATEL FAMILY)

Adoxa moschatellina L. Moschatel

VALERIANACEAE (VALERIAN FAMILY)

Valeriana dioica L. **Northern Valerian**

DIPSACACEAE (TEASEL FAMILY)

Knautia arvensis (L.) Duby **Field Scabious**

CUCURBITACEAE (GOURD FAMILY)

Echinocystis lobata (Michx.) T. & G. **Wild Cucumber. Prickly Cucumber**
Thladiantha dubia Bunge **Manchu Tuber-gourd**

CAMPANULACEAE (BLUEBELL FAMILY)

Campanula aparinoides Pursh **Marsh Bellflower**
rapunculoides L. **Creeping Bluebell**
rotundifolia L. **Harebell. Barbell**
trachelium L. **Nettle-leaved Bellflower. Bats-in-the-Belfry**
uliginosa Rydb. **Marsh Bellflower**
uniflora L. **Alpine Bluebell**

LOBELIACEAE (LOBELIA FAMILY)

Lobelia dortmanna L. **Water Lobelia**
kalmii L. **Kalm's Lobelia**
siphilitica L. **Great Lobelia. Great Lobelia**
spicata Lam. **Pale-spike Lobelia. Spiked Lobelia**

COMPOSITAE (COMPOSITE FAMILY)

Achillea millefolium L. **Common Yarrow. Milfoil. Yarrow**
ptarmica L **Sneezeweed**
sibirica Ledeb. **Many-flowerd Yarrow**
Agoseris glauca (Nutt.) Greene **False Dandelion**
Ambrosia artemisiifolia L. **Common Ragweed**
psilostachya DC. **Perennial Ragweed**
trifida L. **Great Ragweed. Buffalo-weed**
Anaphalis margaritacea (L.) C.B. Clarke **Pearly Everlasting**
Antennaria neglecta Greene **Field Cat's-foot**
parvifolia Nutt. **Small-leaved Everlasting**
plantaginifolia (L.) Hook. **Plantain-leaved Everlasting**
pulcherrima (Hook.) Greene **Showy Everlasting**
rosea Greene **Rosy Everlasting**
umbrellina Rydb. **Brown-bracted Mountain Everlasting**
Anthemis cotula L. **Mayweed. Dog-Fennel. Stinking Mayweed**
tinctoria L **Yellow Chamomille**
Arctium lappa L. **Great or Common Burdock**
minus (Hill) Bernh. **Common or Lesser Burdock**
nemorosum Lej.
tomentosum Mill. **Cotton Burdock**
Arnica alpina (L.) Olin **Arctic Arnica**
chamissonis Less. **Leafy Arnica**
cordifolia Hook. **Heart-leaf Arnica**
fulgens Pursh **Shining Arnica**
lonchophylla Greene
Artemisia abrotanum L. **Southernwood. Lemonwood**
absinthium L. **Wormwood. Absinthe**
biennis Willd. **Biennial Wormwood**
campestris L. **Sagewort. Wormwood. Plains Wormwood**
cana Pursh **Silvery Sagebrush. Hoary Sagebrush**
canadensis Michx. **Canada Wormwood**
dracunculus L. **Tarragon**
frigida Willd. **Prairie-Sagewort. Pasture Sage**
longifolia Nutt. **Long-leaved Sage**
ludoviciana Nutt. **Western Mugwort. White or Prairie Sage**
pontica L. **Roman Wormwood**
tilesii Ledeb. **Herriot's Sage**
vulgaris L. **Common Mugwort. Common Wormwood**
Aster borealis (T. & G.) Provencher
ciliolatus Lindl. **Lindley's Aster**
cordifolius L. **Common Blue Wood Aster**
ericoides L. **Heath or Many-flowered Aster**
johannensis Fern.
laevis L. **Smooth Aster**
lateriflorus (L.) Britt. **Calico or Wood Aster**
laurentianus Fern.
macrophyllus L. **Whitewood Aster**
modestus Lindl. **Large Northern Aster**
novae-angliae L. **New England Aster**
pauciflorus Nutt. **Few-flowered Aster**
praealtus Poir.
ptarmicoides (Nees) T. & G. **White Upland Aster**
puniceus L. **Purple-stemmed Aster**
sagittifolius Wedemeyer **Arrow-leaved Aster**
sericeus Vent. **Western Silvery Aster**
simplex Willd. **Small Blue Aster**
umbellatus Mill. **Flat-topped White Aster**
Bidens amplissima Greene
beckii Torr. **Water-Marigold**
cernua L. **Stick-tight. Smooth Beggarticks**
frondosa L. **Beggarticks. Common Beggarticks**
vulgata Greene **Beggarticks. Stick-tight**
Boltonia asteroides (L.) L'Her **White Boltonia**
Carduus nutans L. **Nodding or Musk-Thistle**
Centaurea cyanus L. **Bachelor's-button. Bluebottle. Cornflower**
repens L. **Russian Knapweed. Turkestan Thistle**
solstitialis L. **Yellow Star-thistle**
Chrysanthemum arcticum L. **Arctic Daisy**
leucanthemum L. **Ox-eye-Daisy**
parthenium (L.) Bernh. **Feverfew**
Chrysopsis villosa (Pursh) Nutt. **Hairy Golden-aster**
Cichorium intybus L. **Common Chicory. Blue Sailors. Chicory**
Cirsium arvense (L.) Scop. **Canada Thistle**
discolor (Muhl.) Spreng. **Field Thistle**
drummondii T. & G. **Short-stemmed Thistle**
flodmanii (Rydb.) Arthur **Flodman's Thistle**
muticum Michx. **Swamp thistle**
nutans L. **Musk-Thistle**
undulatum (Nutt.) Spreng. **Wavy-leaved Thistle**
vulgare (Savi) Tenore **Bull Thistle**
Coreopsis tinctoria Nutt. **Common Tickseed**
Crepis runcinata (James) T. & G. **Scapose Hawk's-beard**
tectorum L. **Narrow-leaved Hawk's-beard**
Echinacea pallida Nutt. **Purple Coneflower**
Echinops sphaerocephalus **Common Globe-thistle. Globe-thistle**
Erigeron acris L. **Northern Daisy Fleabane**
asper Nutt. **Rough Fleabane**
caespitosus Nutt. **Tufted Fleabane**
canadensis L. **Horse-weed. Canada Fleabane**
glabellus Nutt. **Smooth Fleabane**
hyssopifolius Michx. **Hyssop-leaved Erigeron**
lonchophyllus Hook. **Hirsute Fleabane**
philadelphicus L. **Philadelphia Fleabane**
strigosus Muhl. **Daisy Fleabane. White-top**
uniflorus L. **Purple Daisy**
Eupatorium perfoliatum L. **Thoroughwort. Boneset**
purpureum L. **Joe-Pye-weed**
Franseria acanthicarpa (Hook.) **Coville Sandbur**
Gaillardia aristata Pursh **Great-flowered Gaillardia**
Galinsoga ciliata (Raf.) Blake **Galinsoga**
parviflora Cav. **Galinsoga**
Gnaphalium uliginosum L. **Low Cudweed**
Grindelia squarrosa (Pursh) Dunal **Curly-cup Gumweed. Gumweed**
Gutierrezia sarothrae (Pursh) Britt. & Rusby **Match-brush. Broom-Snakeroot**
Haplopappus spinulosus (Pursh) DC. **Ironplant. Spiny Ironplant**
Helenium autumnale L. **Common or Mountain Sneezeweed**
Helianthus annuus L. **Common Sunflower. Sunflower**
laetiflorus Pers. **Beautiful Sunflower**
maximiliani Schrad. **Narrow-leaved Sunflower**
nuttallii T & G **Tuberous-rooted Sunflower**
petiolaris Nutt. **Prairie Sunflower**
tuberosus L. **Jerusalem Artichoke**
Heliopsis helianthoides (L.) **Sweet Rough False Sunflower**
Hieracium albiflorum Hook. **White Hawkweed**
aurantiacum L. **Devil's Paint-brush. Orange Hawkweed. King-devil**
canadense Michx.
scabriusculum Schwein
Iva axillaris Pursh **Poverty-weed**
xanthifolia Nutt. **Marsh-Elder**
Krigia biflora (Walt.) Blake **Dwarf Dandelion**
Lactuca biennis (Moench) Fern. **Tall Blue Lettuce**
canadensis L. **Tall Yellow Lettuce**
floridana (L.) Gaertn. **Annual Blue Lettuce**
ludoviciana (Nutt.) Riddell **Western Lettuce**
scariola L. **Prickly Lettuce**
tatarica (L.) Meyer
Lapsana communis L. **Nipplewort. Common Nipplewort**
Liatris ligulistylis (Nels.) **Meadow Blazingstar**
punctata Hook. **Dotted Blazingstar**
Lygodesmia juncea (Pursh) D. Don. **Skeletonweed**
rostrata Gray **Annual Skeletonweed**
Madia glomerata Hook. **Tarweed**
Matricaria ambigua (Ledeb.) Krylof
chamomilla L. **Wild Chamomile**
maritima L. **Scentless Chamomile**
matricarioides (Less.) Porter **Pineapple-weed. Wild Chamomile**
Microseris cuspidata (Pursh) Schultz-Bip **Prairie False Dandelion**
Petasites palmatus (Ait.) Gray **Palmate-leaved Colt's-foot**
sagittatus (Pursh) Gray **Arrow-leaved Colt's-foot**
vitifolius Greene **Vine-leaved Colt's-foot**
Prenanthes alba L. **White Lettuce. Rattlesnake-root**
racemosa Michx. **Glaucous White Lettuce**
Ratibida columnifera (Nutt.) Wooton & Standl. **Long-headed Coneflower**
Rudbeckia hirta L **Black-eyed Susan**
laciniata L. **Tall Coneflower**
Senecio aureus L. **Golden Ragwort**
canus Hook. **Silvery Groundsel**
congestus (R. Br.) DC. **Marsh-Fleabane. Marsh Ragwort**
eremophilus Richards. **Cut-leaved Ragwort**
indecorus Greene **Rayless Ragwort**
integerrimus Nutt. **Entire-leaved Groundsel**
pauperculus Michx. **Balsam Groundsel**
pseudaureus Rydb.
tridenticulatus Rydb. **Compact Groundsel**
viscosus L. **Stinking Groundsel**
vulgaris L. **Common Groundsel**
Silphium terebinthinaceum Jacq. **Prairie-Dock**
Solidago canadensis L. **Canada Goldenrod**
gigantea Ait. **Late Goldenrod**
graminifolia (L.) Salisb. **Flat-topped Goldenrod**
hispida Muhl. **Hairy Goldenrod**
juncea Ait. **Sharp-toothed Goldenrod**
missouriensis Nutt. **Low Goldenrod**
mollis Bartl. **Velvety Goldenrod**
multiradiata Ait. **Alpine Goldenrod**
nemoralis Ait. **Showy Goldenrod**
purshii Porter
riddellii Frank **Riddell's Goldenrod**
rigida L. **Stiff Goldenrod**
spathulata DC. **Mountain Goldenrod**
uliginosa Nutt. **Marsh Goldenrod**
Sonchus arvensis L. **Field or Perennial Sow-thistle**
asper (L.) **Hill Spiny-leaved or Prickly Sow-thistle**
oleraceus L. **Common or Annual Sow-thistle**
Tanacetum huronense Nutt. **Indian Tansy**
vulgare L. Common Tansy. **Golden-buttons. Tansy**
Taraxacum ceratophorum (Ledeb.) DC. **Dandelion**
dumetorum Greene
lacerum Greene
laevigatum (Willd.) DC. **Red-seeded Dandelion**

lapponicum Kihlm.
officinale Weber **Common Dandelion**
Townsendia exscapa (Richards.) Porter **Low Townsendia**
Tragopogon dubius Scop. **Goat's-beard. Yellow Goat's-beard**
porrifolius L. **Salsify. Oyster-plant. Vegetable-oyster**
pratensis L. **Goat's-beard**
Vernonia fasciculata Michx. **Western Ironweed**
Xanthium strumarium L. **Cocklebur**

FISHES

* Introduced
– Marine
‡ Hybrid

***PETROMYZONTIDAE* (LAMPREY FAMILY)**

Ichthyomyzon castaneus Girard **Chestnut Lamprey**
fossor Reighard and Cummins **Northern Brook Lamprey**
unicuspis Hubbs and Trautman **Silver Lamprey**

***ACIPENSERIDAE* (STURGEON FAMILY)**

Acipenser fulvescens Rafinesque **Lake Sturgeon**

***SALMONIDAE* (SALMON FAMILY)**

Coregonus artedi Lesueur **Cisco. Lake Herring**
clupeaformis (Mitchill) **Lake Whitefish**
zenithicus (Jordan and Evermann) **Shortjaw Cisco**
Oncorhynchus nerka (Walbaum) **Sockeye Salmon. Kokanee***
Prosopium cylindraceum (Pallas) **Round Whitefish**
Salmo clarki Richardson **Cutthroat Trout***
gairdneri Richardson **Rainbow Trout. Kamloops Steelhead***
trutta Linnaeus **Brown Trout***
Salvelinus alpinus (Linnaeus) **Arctic Char**
fontinalis\namaycush (Mitchell & Walbaum) **Splake‡**
fontinalis (Mitchill) **Brook Trout**
namaycush (Walbaum) **Lake Trout**
Thymallus arcticus (Pallas) **Arctic Grayling**

***OSMERIDAE* (SMELT FAMILY)**

Mallotus villosus (Muller) **Capelin** –

***HIODONTIDAE* (MOONEYE FAMILY)**

Hiodon alosoides (Rafinesque) **Goldeye**
tergisus Lesueur **Mooneye**

***UMBRIDAE* (MUD MINNOW FAMILY)**

Umbra limi (Kirtland) **Central Mudminnow**

***ESOCIDAE* (PIKE FAMILY)**

Esox lucius Linnaeus **Northern Pike**
masquinongy Mitchill **Muskellunge**

***CYPRINIDAE* (MINNOW OR CARP FAMILY)**

Carassius auratus (Linnaeus) **Goldfish***
Couesius plumbeus (Agassiz) **Lake Chub**
Cyprinus carpio Linnaeus **Carp***
Hybognathus hankinsoni Hubbs **Brassy Minnow**
Hybopsis gracilis (Richardson) **Flathead Chub**
storeriana (Kirtland) **Silver Chub**
Nocomis biguttatus (Kirtland) **Hornyhead Chub**
Notemigonus crysoleucas (Mitchill) **Golden Shiner**
Notropus atherinoides Rafinesque **Emerald Shiner**
blennius (Girard) **River Shiner**
cornutus (Mitchill) **Common Shiner**
dorsalis (Agassiz) **Bigmouth Shiner**
heterodon (Cope) **Blackchin Shiner**
heterolepis Eigenmann and Eigenmann **Blacknose Shiner**
hudsonius (Clinton) **Spottail Shiner**
rubellus (Agassiz) **Rosyface Shiner**
spilopterus (Cope) **Spotfin Shiner**
stramineus (Cope) **Sand Shiner**
texanus (Girard) **Weed Shiner**
volucellus (Cope) **Mimic Shiner**
Phenacobius mirabilis (Cope) **Northern Redbelly Dace**
Phoxinus neogaeus (Cope) **Finescale Dace**
eos-neogaeus (Rafinesque) **Bluntnose Minnow**
Pimephales promelas Rafinesque **Fathead Minnow**
Rhinichthys atratulus (Hermann) **Blacknose Dace**
cataractae (Valenciennes) **Longnose Dace**
Semotilus atromaculatus (Mitchill) **Creek Chub**
margarita (Cope) **Pearl Dace**

***CATOSTOMIDAE* (SUCKER FAMILY)**

Carpiodes cyprinus (Lesueur) **Quillback**
Catostomus catostomus (Forster) **Longnose Sucker**
commersoni (Lacepede) **White Sucker**
Ictiobus cyprinellus (Valenciennes) **Bigmouth Buffalo**
Moxostoma anisurum (Rafinesque) **Silver Redhorse**
erythrurum (Rafinesque) **Golden Redhorse**
macrolepidotum (Lesueur) **Shorthead Redhorse**

***ICTALURIDAE* (CATFISH FAMILY)**

Ictalurus melas (Rafinesque) **Black Bullhead**
nebulosus (Lesueur) **Brown Bullhead**
punctatus (Rafinesque) **Channel Catfish**
Noturus gyrinus (Mitchill) **Tadpole Madtom**
Noturus flavus Rafinesque **Stonecat**

***CYPRINODONTIDAE* (KILLIFISH FAMILY)**

Fundulus diaphanus (Lesueur) **Banded Killifish**

***GADIDAE* (COD FAMILY)**

Lota lota (Linnaeus) Brook **Burbot**

***GASTEROSTEIDAE* (STICKLEBACK FAMILY)**

Culaea inconstans (Kirtland) **Stickleback**
Gasterosteus aculeatus Linnaeus **Threespine Stickleback** –
Pungitius pungitius (Linnaeus) **Ninespine Stickleback**

***PERCOPSIDAE* (TROUT-PERCH FAMILY)**

Percopsis omiscomaycus (Walbaum) **Trout-perch**

***CENTRARCHIDAE* (SUNFISH FAMILY)**

Ambloplites rupestris (Rafinesque) **Rock Bass**
Lepomis gibbosus (Linnaeus) **Pumpkinseed**
macrochirus Rafinesque **Bluegill**
Micropterus dolomieui Lacepede **Smallmouth Bass***
salmoides Lacepede **Largemouth Bass***
Morone chrysops (Rafinesque) **White Bass***
Pomoxis annularis Rafinesque **White Crappie***
Pomoxis nigromaculatus (Lesueur) **Black Crappie***

***PERCIDAE* (PERCH FAMILY)**

Etheostoma exile (Girard) **Iowa Darter**
nigrum Rafinesque **Johnny Darter**
Perca flavescens (Mitchill) **Yellow Perch**
Percina caprodes (Rafinesque) **Logperch**
maculata (Girard) **Blackside Darter**
shumardi (Girard) **River Darter**
Stizostedion canadense (Smith) **Sauger**
vitreum (Mitchill) **Walleye**

***SCIAENIDAE* (DRUM OR CROAKER FAMILY)**

Aplodinotus grunniens Rafinesque **Freshwater Drum**

***COTTIDAE* (SCULPIN FAMILY)**

Cottus bairdi Girard **Mottled Sculpin**
cognatus Richardson **Slimy Sculpin**
ricei (Nelson) **Spoonhead Sculpin**
Myoxocephalus quadricornis (Linnaeus) **Deepwater Sculpin** –
scorpioides (Fabricius) **Arctic Sculpin** –
scorpius (Linnaeus) **Shorthorn Sculpin** –
thompsoni (Girard) **Deepwater Sculpin**

AMPHIBIANS

Necturus maculosus maculosus (Rafinesque) **Mudpuppy**
Ambystoma laterale Hallowell **Blue-spotted Salamander**
Ambystoma tigrinum tigrinum (Green) **Eastern Tiger Salamander**
Ambystoma tigrinum diaboli Dunn **Gray Tiger Salamander**
Bufo americanus americanus Holbrook **American Toad**
Bufo americanus hemiophrys Cope **Canadian Toad**
Bufo cognatus (Say) **Great Plains Toad**
Scaphiopus bombifrons Cope **Plains Spadefoot Toad**
Hyla crucifer crucifer Wied **Northern Spring Peeper**
Hyla chrysoscelis Cope **Cope's Gray Treefrog**
Hyla versicolor Le Conte **Gray Treefrog**
Pseudacris triseriata maculata (Agassiz) **Boreal Chorus Frog**
Rana clamitans melanota (Rafinesque) **Green Frog**
Rana septentrionalis Baird **Mink Frog**
Rana pipiens Schreber **Northern Leopard Frog**
Rana sylvatica Le Conte **Wood Frog**

REPTILES

Chelydra serpentina serpentina Linnaeus **Common Snapping Turtle**
Chrysemys picta bella (Gray) **Western Painted Turtle**
Eumeces septentrionalis septentrionalis Baird **Northern Prairie Skink**
Storeria occipitomaculata occipitomaculata (Storer) **Northern Redbelly Snake**
Thamnophis sirtalis parietalis (Say) **Red-sided Garter Snake**
Opheodrys vernalis (Harlan) **Smooth Green Snake**
Thamnophis radix haydeni (Kennicott) **Western Plains Garter Snake**
Heterodon nasicus nasicus Baird and Girard **Plains Hognose Snake**

BIRDS

* Introduced
– Extirpated
† Extinct

***GAVIIDAE* (LOONS)**

Gavia adamsii (Gray) **Yellow-billed Loon**
immer (Brunnich) **Common Loon**
pacifica (Lawrence) **Pacific Loon**
stellata (Pontoppidan) **Red-throated Loon**

***PODICIPEDIDAE* (GREBES)**

Aechmophorus clarkii (Lawrence) **Clark's Grebe**
occidentalis (Lawrence) **Western Grebe**
Podiceps auritus (Linnaeus) **Horned Grebe**
Podiceps grisegena (Boddaert) **Red-necked Grebe**
nigricollis C.L. Brehm **Eared Grebe**
Podilymbus podiceps (Linnaeus) **Pied-billed Grebe**

***PELECANIDAE* (PELICANS)**

Pelecanus erythrorhynchos Gmelin **American White Pelican**

***PHALACROCORACIDAE* (CORMORANTS)**

Phalacrocorax auritus (Lesson) **Double-crested Cormorant**

***ARDEIDAE* (HERONS AND BITTERNS)**

Ardea herodias Linnaeus **Great Blue Heron**
Botaurus lentiginosus (Rackett) **American Bittern**
Bubulcus ibis (Linnaeus) **Cattle Egret**
Butorides striatus (Linnaeus) **Green-backed Heron**
Casmerodius albus (Linnaeus) **Great Egret**

Egretta caerulea (Linnaeus) **Little Blue Heron**
thula (Molina) **Snowy Egret**
tricolor (Muller) **Tricolored Heron**
Ixobrychus exilis (Gmelin) **Least Bittern**
Nycticorax nycticorax (Linnaeus) **Black-crowned Night-Heron**
violaceus (Linnaeus) **Yellow-crowned Night-Heron**

ANATIDAE (SWANS, GEESE, AND DUCKS)

Aix sponsa (Linnaeus) **Wood Duck**
Anas acuta Linnaeus **Northern Pintail**
americana Gmelin **American Wigeon**
clypeata Linnaeus **Northern Shoveler**
crecca Linnaeus **Green-winged Teal**
cyanoptera Vieillot **Cinnamon Teal**
discors Linnaeus **Blue-winged Teal**
penelope Linnaeus **Eurasian Wigeon**
platyrhynchos Linnaeus **Mallard**
querquedula Linnaeus **Garganey**
rubripes Brewster **American Black Duck**
strepera Linnaeus **Gadwall**
Anser albifrons (Scopoli) **Great White-fronted Goose**
caerulescens (Linnaeus) **Snow Goose**
rossii Cassin **Ross's Goose**
Aythya affinis (Eyton) **Lesser Scaup**
americana (Eyton) **Redhead**
collaris (Donovan) **Ring-necked Duck**
marila (Linnaeus) **Greater Scaup**
valisineria (Wilson) **Canvasback**
Branta bernicla (Linnaeus) **Brant**
canadensis (Linnaeus) **Canada Goose**
Bucephala albeola (Linnaeus) **Bufflehead**
clangula (Linnaeus) **Common Goldeneye**
islandica (Gmelin) **Barrow's Goldeneye**
Clangula hyemalis (Linnaeus) **Oldsquaw**
Cygnus buccinator Richardson **Trumpeter Swan** ∞
columbianus (Ord) **Tundra or Whistling Swan**
Histrionicus histrionicus (Linnaeus) **Harlequin Duck**
Lophodytes cucullatus (Linnaeus) **Hooded Merganser**
Melanitta fusca (Linnaeus) **White-winged Scoter**
nigra (Linnaeus) **Black Scoter**
perspicillata (Linnaeus) **Surf Scoter**
Mergus merganser Linnaeus **Common Merganser**
serrator Linnaeus **Red-breasted Merganser**
Oxyura jamaicensis (Gmelin) **Ruddy Duck**
Somateria mollissima (Linnaeus) **Common Eider**
spectabilis (Linnaeus) **King Eider**

CATHARTIDAE (AMERICAN VULTURES)

Cathartes aura (Linnaeus) **Turkey Vulture**

ACCIPITRIDAE (OSPREY, KITES, EAGLES, AND HAWKS)

Accipiter cooperii (Bonaparte) **Cooper's Hawk**
gentilis (Linneaus) **Northern Goshawk**
striatus Vieillot **Sharp-shinned Hawk**
Aquila chrysaetos (Linnaeus) **Golden Eagle**
Buteo jamaicensis (Gmelin) **Red-tailed Hawk**
lagopus (Pontopiddan) **Rough-legged Hawk**
lineatus (Gmelin) **Red-shouldered Hawk**
platypterus (Vieillot) **Broad-winged Hawk**
regalis (Gray) **Ferruginous Hawk**
swainsoni Bonaparte **Swainson's Hawk**
Circus cyaneus (Linnaeus) **Northern Harrier**
Haliaeetus leucocephalus (Linnaeus) **Bald Eagle**
Pandion haliaetus (Linnaeus) **Osprey**

FALCONIDAE (FALCONS)

Falco columbarius Linnaeus **Merlin**
Falco mexicanus Schlegel **Prairie Falcon**
peregrinus Tunstall **Peregrine Falcon**
rusticolis Linnaeus **Gyrfalcon**
sparverius Linneaus **American Kestrel**

PHASIANIDAE (PARTRIDGES, PHEASANT, GROUSE, TURKEYS, AND QUAIL)

Bonasa umbellus (Linnaeus) **Ruffed Grouse**
Dendragapus canadensis (Linnaeus) **Spruce Grouse**
Lagopus lagopus (Linnaeus) **Willow Ptarmigan**
mutus (Montin) **Rock Ptarmigan**
Meleagris gallopavo Linnaeus **Wild Turkey***
Perdix perdix (Linnaeus) **Gray (Hungarian) Partridge***
Phasianus colchicus Linnaeus **Ring-necked Pheasant***
Tympanuchus cupido (Linnaeus) **Greater Prairie Chicken** ∞
phasianellus (Linnaeus) **Sharp-tailed Grouse**

RALLIDAE (RAILS, GALLINULES, AND COOTS)

Coturnicops noveboracensis (Gmelin) **Yellow Rail**
Fulica americana Gmelin **American Coot**
Gallinula chloropus (Linnaeus) **Common Moorhen**
Porzana carolina (Linnaeus) **Sora**
Rallus elegans Audubon **King Rail**
limicola Vieillot **Virginia Rail**

GRUIDAE (CRANES)

Grus americana (Linnaeus) **Whooping Crane**
canadensis (Linnaeus) **Sandhill Crane**

CHARADRIIDAE (PLOVERS)

Charadrius melodus Ord **Piping Plover**
semipalmatus Bonaparte **Semipalmated Plover**
vociferus Linnaeus **Killdeer**
Pluvialis dominica (Muller) **Lesser Golden Plover**
squatarola (Linnaeus) **Black-bellied Plover**

RECURVIROSTRIDAE (AVOCETS AND STILTS)

Himantopus mexicanus (Muller) **Black-necked Stilt**
Recurvirostra americana Gmelin **American Avocet**

SCOLOPACIDAE (SANDPIPERS AND PHALAROPES)

Actitis macularia (Linnaeus) **Spotted Sandpiper**
Arenaria interpres (Linnaeus) **Ruddy Turnstone**
Bartramia longicauda (Bechstein) **Upland Sandpiper**
Calidris alba (Pallas) **Sanderling**
alpina (Linnaeus) **Dunlin**
bairdii (Coues) **Baird's Sandpiper**
canutus (Linnaeus) **Red Knot**
ferruginea (Bonaparte) **Curlew Sandpiper**
fuscicollus (Vieillot) **White-rumped Sandpiper**
himantopus (Bonaparte) **Stilt Sandpiper**
maritima (Brunnich) **Purple Sandpiper**
mauri (Cabanis) **Western Sandpiper**
melanotos (Vieillot) **Pectoral Sandpiper**
minutilla (Vieillot) **Least Sandpiper**
pusilla (Linnaeus) **Semipalmated Sandpiper**
Catoptrophorus semipalmatus (Gmelin) **Willet**
Gallinago gallinago (Linnaeus) **Common Snipe**
Heteroscelus incanus (Gmelin) **Wandering Tattler**
Limnodromus griseus (Gmelin) **Short-billed Dowitcher**
Limnodromus scolopaceus (Say) **Long-billed Dowitcher**
fedoa (Linnaeus) **Marbled Godwit**
Limosa haemastica (Linnaeus) **Hudsonian Godwit**
Numenius americanus Bechstein **Long-billed Curlew**
borealis (Forster) **Eskimo Curlew** ∞
phaeopus (Linnaeus) **Whimbrel**
Phalaropus fulicaria (Linnaeus) **Red Phalarope**
lobatus (Linnaeus) **Red-necked Phalarope**
tricolor (Vieillot) **Wilson's Phalarope**
Philomachus pugnax (Linnaeus) **Ruff**
Scolopax minor Gmelin **American Woodcock**
Tringa flavipes (Gmelin) **Lesser Yellowlegs**
melanoleuca (Gmelin) **Greater Yellowlegs**
solitaria Wilson **Solitary Sandpiper**
Tryngites subruficollis (Vieillot) **Buff-breasted Sandpiper**

LARIDAE (SKUAS, GULLS, TERNS, AND SKIMMERS)

Chlidonias niger (Linnaeus) **Black Tern**
Larus argentatus Pontoppidan **Herring Gull**
atricilla Linnaeus **Laughing Gull**
californicus Lawrence **California Gull**
canus Linnaeus **Mew Gull**
delawarensis Ord **Ring-billed Gull**
fuscus Linnaeus **Lesser Black-backed Gull**
glaucescens Naumann **Glaucous-winged Gull**
glaucoides Meyer **Iceland Gull**
glaucoides thayeri Brooks **Thayer's Gull**
hyperboreus Gunnerus **Glaucous Gull**
marinus Linnaeus **Great Black-backed Gull**
minutus Pallas **Little Gull**
philadelphia (Ord) **Bonaparte's Gull**
pipixcan Wagler **Franklin's Gull**
ridibundus Linnaeus **Common Black-headed Gull**
Pagophila eburnea (Phipps) **Ivory Gull**
Rhodostethia rosea (Macgillivray) **Ross's Gull**
Rissa tridactyla (Linnaeus) **Black-legged Kittiwake**
Stercorarius longicaudus Vieillot **Long-tailed Jaeger**
parasiticus (Linnaeus) **Parasitic Jaeger**
pomarinus (Temminck) **Pomerine Jaeger**
Sterna caspia Pallas **Caspian Tern**
forsteri Nuttall **Forster's Tern**
hirundo Linnaeus **Common Tern**
paradisaea Pontoppidan **Arctic Tern**
Xema sabini (Sabine) **Sabine's Gull**

ALCIDAE (AUKS, MURRES, AND PUFFINS)

Alle alle (Linnaeus) **Dovekie**
Cepphus grylle (Linnaeus) **Black Guillemot**
Synthliboramphus hypoleucus (Xantus) **Ancient Murrelet**

COLUMBIDAE (PIGEONS AND DOVES)

Columba fasciata Say **Band-tailed Pigeon**
livia Gmelin **Rock Dove***
Ectopistes migratorius (Linnaeus) **Passenger Pigeon†**
Zenaida macroura (Linnaeus) **Mourning Dove**

CUCULIDAE (CUCKOOS)

Coccyzus americanus (Linnaeus) **Yellow-billed Cuckoo**
erythropthalmus (Wilson) **Black-billed Cuckoo**

TYTONIDAE (BARN OWLS)

Tyto alba (Scopoli) **Common Barn-owl**

STRIGIDAE (TYPICAL OWLS)

Aegolius acadicus (Gmelin) **Northern Saw-whet Owl**
funereus (Linnaeus) **Boreal Owl**
Asio flammeus (Pontopiddan) **Short-eared Owl**
otus (Linnaeus) **Long-eared Owl**
Athene cunicularia (Molina) **Burrowing Owl**
Bubo virginianus (Gmelin) **Great Horned Owl**
Nyctea scandiaca (Linnaeus) **Snowy Owl**
Otus asio (Linnaeus) **Eastern Screech Owl**
Strix nebulosa Forster **Great Gray Owl**
varia Barton **Barred Owl**
Surnia ulula (Linnaeus) **Northern Hawk-Owl**

CAPRIMULGIDAE (GOATSUCKERS)

Caprimulgus vociferus Wilson **Whip-poor-will**
Chordeiles minor (Forster) **Common Nighthawk**

APODIDAE (SWIFTS)

Chaetura pelagica (Linnaeus) **Chimney Swift**

TROCHILIDAE (HUMMINGBIRDS)

Archilochus colubris (Linnaeus) **Ruby-throated Hummingbird**
Selasphorus rufus (Gmelin) **Rufous Hummingbird**

***ALCEDINIDAE* (KINGFISHERS)**

Ceryle alcyon (Linnaeus) **Belted Kingfisher**

***PICIDAE* (WOODPECKERS)**

Colaptes auratus (Linnaeus) **Northern Flicker**
Dryocopus pileatus (Linneaus) **Pileated Woodpecker**
Melanerpes carolinus (Linnaeus) **Red-bellied Woodpecker**
erythrocephalus (Linnaeus) **Red-headed Woodpecker**
lewis (Gray) **Lewis's Woodpecker**
Picoides arcticus (Swainson) **Black-backed Woodpecker**
pubescens (Linnaeus) **Downy Woodpecker**
tridactylus (Linnaeus) **Three-toed Woodpecker**
villosus (Linnaeus) **Hairy Woodpecker**
Sphyrapicus varius (Linnaeus) **Yellow-bellied Sapsucker**

***TYRANNIDAE* (TYRANT FLYCATCHERS)**

Contopus borealis (Swainson) **Olive-sided Flycatcher**
cooperdulus Sclater **Western Wood-Peewee**
virens (Linnaeus) **Eastern Wood-Peewee**
Empidonax alnorum Brewster **Alder Flycatcher**
flaviventris (Baird and Baird) **Yellow-bellied Flycatcher**
minimus (Baird and Baird) **Least Flycatcher**
traillii (Audubon) **Willow Flycatcher**
Myiarchus crinitus (Linnaeus) **Great Crested Flycatcher**
Sayornis phoebe (Latham) **Eastern Phoebe**
saya (Bonaparte) **Say's Phoebe**
Tyrannus forficatus (Gmelin) **Scissor-tailed Flycatcher**
tyrannus (Linnaeus) **Eastern Kingbird**
verticalis Say **Western Kingbird**

***ALAUDIDAE* (LARKS)**

Eremophila alpestris (Linneaus) **Horned Lark**

***HIRUNDINIDAE* (SWALLOWS)**

Hirundo pyrrhonota Vieillot **Cliff Swallow**
rustica Linnaeus **Barn Swallow**
Progne subis (Linnaeus) **Purple Martin**
Riparia riparia (Linnaeus) **Bank Swallow**
Stelgidopteryx serripennis (Audubon) **Northern Rough-winged Swallow**
Tachycineta bicolor (Vieillot) **Tree Swallow**
thalassina (Swainson) **Violet Green Swallow**

***CORVIDAE* (JAYS, MAGPIES, AND CROWS)**

Corvus brachyrhynchos Brehm **American Crow**
corax Linnaeus **Common Raven**
Cyanocitta cristata (Linnaeus) **Blue Jay**
Nucifraga columbiana (Wilson) **Clark's Nutcracker**
Perisoreus canadensis (Linnaeus) **Gray Jay**
Pica pica (Linnaeus) **Black-billed Magpie**

***PARIDAE* (TITMICE)**

Parus atricapillus Linnaeus **Black-capped Chickadee**
hudsonicus Forster **Boreal Chickadee**

***SITTIDAE* (NUTHATCHES)**

Sitta canadensis Linnaeus **Red-breasted Nuthatch**
carolinensis Latham **White-breasted Nuthatch**

***CERTHIIDAE* (CREEPERS)**

Certhia americana Bonaparte **Brown Creeper**
Thryothorus ludovicianus (Latham) **Carolina Wren**

***TROGLODYTIDAE* (WRENS)**

Cistothorus palustris (Wilson) **Marsh Wren**
platensis (Latham) **Sedge Wren**
Salpinctes obsoletus (Say) **Rock Wren**
Troglodytes aedon Vieillot **House Wren**
troglodytes (Linnaeus) **Winter Wren**

***MUSCICAPIDAE* (THRUSHES AND OLD-WORLD WARBLERS)**

Catharus fuscescens (Stephens) **Veery**
guttatus (Pallas) **Hermit Thrush**
minimus (Lafresnaye) **Gray-cheeked Thrush**
ustulatus (Nuttall) **Swainson's Thrush**
Hylocichla mustelina (Gmelin) **Wood Thrush**
Ixoreus naevius (Gmelin) **Varied Thrush**
Myadestes townsendi (Audubon) **Townsend's Solitaire**
Polioptila caerulea (Linneaus) **Blue-gray Gnatcatcher**
Regulus calendula (Linnaeus) **Ruby-crowned Kinglet**
satrapa Lichtenstein **Golden-crowned Kinglet**
Sialia currucoides (Bechstein) **Mountain Bluebird**
sialis (Linnaeus) **Eastern Bluebird**
Turdus migratorius Linnaeus **American Robin**

***MIMIDAE* (MOCKINGBIRDS AND THRASHERS)**

Dumetella carolinensis (Linnaeus) **Gray Catbird**
Mimus polyglottos (Linneaus) **Northern Mockingbird**
Oreoscoptes montanus (Townsend) **Sage Thrasher**
Toxostoma bendirei (Coues) **Bendire's Thrasher**
rufum (Linnaeus) **Brown Thrasher**

***MOTACILLIDAE* (WAGTAILS AND PIPITS)**

Anthus spinoletta (Linnaeus) **Water Pipit**
spragueii (Audubon) **Sprague's Pipit**

***BOMBYCILLIDAE* (WAXWINGS)**

Bombycilla cedrorum Vieillot **Cedar Waxwing**
garrulus (Linnaeus) **Bohemian Waxwing**

***LANIIDAE* (SHRIKES)**

Lanius excubitor Linnaeus **Northern Shrike**
ludovicianus Linnaeus **Loggerhead Shrike**

***STURNIDAE* (STARLINGS)**

Sturnus vulgaris Linnaeus **European Starling***

***VIREONIDAE* (VIREOS)**

Vireo flavifrons Vieillot **Yellow-throated Vireo**
gilvus (Vieillot) **Warbling Vireo**
griseus (Boddaert) **White-eyed Vireo**
olivaceus (Linnaeus) **Red-eyed Vireo**
philadelphicus (Cassin) **Philadelphia Vireo**
solitarius (Wilson) **Solitary Vireo**

***EMBERIZIDAE* (WARBLERS, TANAGERS, CARDINALS, SPARROWS, BUNTINGS, MEADOWLARKS, BLACKBIRDS, AND ORIOLES)**

Agelaius phoeniceus (Linnaeus) **Red-winged Blackbird**
Ammodramus bairdii (Audubon) **Baird's Sparrow**
caudacutus (Gmelin) **Sharp-tailed Sparrow**
leconteii (Audubon) **Le Conte's Sparrow**
savannarum (Gmelin) **Grasshopper Sparrow**
Calamospiza melanocorys Steineger **Lark Bunting**
Calcarius lapponicus (Linnaeus) **Lapland Longspur**
mccownii (Lawrence) **McCown's Longspur**
ornatus (Townsend) **Chestnut-collared Longspur**
pictus (Swainson) **Smith's Longspur**
Cardinalis cardinalis (Linnaeus) **Northern Cardinal**
Chondestes grammacus (Say) **Lark Sparrow**
Dendroica caerulescens (Gmelin) **Black-throated Blue Warbler**
castanea (Wilson) **Bay-breasted Warbler**
cerulea (Wilson) **Cerulean Warbler**
coronata (Linnaeus) **Yellow-rumped Warbler**
discolor (Vieillot) **Prairie Warbler**
dominica (Linnaeus) **Yellow-throated Warbler**
fusca (Muller) **Blackburnian Warbler**
magnolia (Wilson) **Magnolia Warbler**
palmarum (Gmelin) **Palm Warbler**
pensylvanica (Linnaeus) **Chestnut-sided Warbler**
petechia (Linnaeus) **Yellow Warbler**
pinus (Wilson) **Pine Warbler**
striata (Forster) **Blackpoll Warbler**
tigrina (Gmelin) **Cape May Warbler**
virens (Gmelin) **Black-throated Green Warbler**
Dolichonyx oryzivorus (Linnaeus) **Bobolink**
Euphagus carolinus (Muller) **Rusty Blackbird**
cyanocephalus (Wagler) **Brewer's Blackbird**
Geothlypis trichas (Linnaeus) **Common Yellowthroat**
Icteria virens (Linnaeus) **Yellow-breasted Chat**
galbula (Linnaeus) **Northern Oriole**
spurius (Linnaeus) **Orchard Oriole**
Junco hyemalis (Linnaeus) **Dark-eyed Junco**
Melospiza georgiana (Latham) **Swamp Sparrow**
lincolnii (Audubon) **Lincoln's Sparrow**
melodia (Wilson) **Song Sparrow**
Mniotilta varia (Linnaeus) **Black-and-white Warbler**
Molothrus ater (Boddaert) **Brown-headed Cowbird**
Oporornis agilis (Wilson) **Connecticut Warbler**
philadelphia (Wilson) **Mourning Warbler**
Parula americana (Linnaeus) **Northern Parula**
Passerculus sandwichensis (Gmelin) **Savannah Sparrow**
Passerella iliaca (Merrem) **Fox Sparrow**
Passerina amoena (Say) **Lazuli Bunting**
cyanea (Linnaeus) **Indigo Bunting**
Pheucticus ludovicianus (Linnaeus) **Rose-breasted Grosbeak**
melanocephalus (Swainson) **Black-headed Grosbeak**
Pipilo chlorurus (Audubon) **Green-tailed Towhee**
erythrophthalmus (Linnaeus) **Rufous-sided Towhee**
Piranga ludoviciana (Wilson) **Western Tanager**
olivacea (Gmelin) **Scarlet Tanager**
rubra (Linnaeus) **Summer Tanager**
Plectrophenax nivalis (Linnaeus) **Snow Bunting**
Poecetes gramineus (Gmelin) **Vesper Sparrow**
Quiscalus quiscula (Linnaeus) **Common Grackle**
Seiurus aurocapillus (Linneaus) **Ovenbird**
noveboracensis (Gmelin) **Northern Waterthrush**
Setophaga ruticilla (Linnaeus) **American Redstart**
Spiza americana (Gmelin) **Dickcissel**
Spizella arborea (Wilson) **American Tree Sparrow**
pallida (Swainson) **Clay-colored Sparrow**
passerina (Bechstein) **Chipping Sparrow**
pusilla (Wilson) **Field Sparrow**
Sturnella magna (Linnaeus) **Eastern Meadowlark**
neglecta Audubon **Western Meadowlark**
Vermivora celata (Say) **Orange-crowned Warbler**
chrysoptera (Linnaeus) **Golden-winged Warbler**
peregrina (Wilson) **Tennessee Warbler**
ruficapilla (Wilson) **Nashville Warbler**
Wilsonia canadensis (Linnaeus) **Canada Warbler**
citrina (Boddaert) **Hooded Warbler**
pusilla (Wilson) **Wilson's Warbler**
Xanthocephalus xanthocephalus (Bonaparte) **Yellow-headed Blackbird**
Zonotrichia albicollis (Gmelin) **White-throated Sparrow**
atricapilla (Gmelin) **Golden-crowned Sparrow**
leucophrys (Forster) **White-crowned Sparrow**
querula (Nuttall) **Harris's Sparrow**

***FRINGILLIDAE* (FINCHES)**

Carduelis flammea (Linnaeus) **Common Redpoll**
hornemanni (Holboll) **Hoary Redpoll**
pinus (Wilson) **Pine Siskin**
tristis (Linnaeus) **American Goldfinch**
Carpodacus mexicanus (Muller) **House Finch**
purpureus (Gmelin) **Purple Finch**
Coccothraustes vespertinus (Cooper) **Evening Grosbeak**
Fringilla montifringilla Linnaeus **Brambling**
Leucosticte arctoa (Pallas) **Rosy Finch**
Loxia curvirostra Linnaeus **Red Crossbill**
leucoptera Gmelin **White-winged Crossbill**
Pinicola enucleator (Linnaeus) **Pine Grosbeak**

***PASSERIDAE* (OLD WORLD SPARROWS)**

Passer domesticus (Linnaeus) **House Sparrow***
Passer montanus Linnaeus **Eurasian (European) Tree Sparrow***

MAMMALS

* Introduced
∞ Extirpated
† Extinct

***SORICIDAE* (SHREWS)**

Blarina brevicauda Say **Shorttailed Shrew**
Microsorex hoyi Baird **Pigmy Shrew**
Sorex arcticus Kerr **Arctic Shrew**
cinereus Kerr **Masked Shrew**
obscurus Merriam **Dusky Shrew**
palustris Richardson **Water Shrew**

***TALPIDAE* (MOLES)**

Condylura cristata Linnaeus **Starnosed Mole**

***VESPERTILIONIDAE* (SMOOTH-FACED BATS)**

Eptesicus fuscus Palisot de Beauvios **Big Brown Bat**
Lasionycteris noctivagans LeConte **Silver-haired Bat**
Lasiurus cinereus Palisot de Beauvois **Hoary Bat**
borealis Muller **Red Bat**
Myotis keenii Merriam **Keen's Myotis. Keen's Bat**
lucifugus LeConte **Little Brown Myotis. Little Brown Bat**

***LEPORIDAE* (RABBITS AND HARES)**

Lepus americanus Erxleben **Snowshoe Hare**
arcticus Ross **Arctic Hare**
townsendii Bachman **Whitetailed Jackrabbit**
Sylvilagus floridanus J.A.Allen **Eastern Cottontail**

***SCIURIDAE* (SQUIRRELS)**

Eutamias minimus Bachman **Least Chipmunk**
Glaucomys sabrinus Shaw **Northern Flying Squirrel**
Marmota monax Linnaeus **Woodchuck**
Sciurus carolinensis Gmelin **Gray Squirrel**
niger Linnaeus **Fox Squirrel**
Spermophilus franklinii Sabine **Franklin's Ground Squirrel**
parryii (Richardson) **Arctic Ground Squirrel**
richardsonii Sabine **Richardson's Ground Squirrel**
tridecemlineatus Mitchell **Thirteen-lined Ground Squirrel**
Tamias striatus Linnaeus **Eastern Chipmunk**
Tamiasciurus hudsonicus Erxleben **Red Squirrel**

***GEOMYIDAE* (POCKET GOPHERS)**

Geomys bursarius (Shaw) **Plains Pocket Gopher**
Thomomys talpoides Richardson **Northern Pocket Gopher**

***MURIDAE* (RATS, MICE, AND VOLES)**

Clethrionomys gapperi Vigors **Gapper's Redbacked Vole**
rutilus Pallas **Northern Redbacked Vole**
Dicrostonyx torquatus Pallas **Collared Lemming**
Lemmus sibiricus Kerr **Brown Lemming**
Microtus ochrogaster Wagner **Prairie Vole**
pennsylvanicus Ord **Meadow Vole**
xanthognathus Leach **Yellow-cheeked Vole**
Mus musculus Linnaeus **House Mouse***
Ondatra zibethicus Linnaeus **Muskrat**
Peromyscus maniculatus Wagner **Deer Mouse**
Phenacomys intermedius Merriam **Heather Vole**
Rattus norvegicus Berkenhout **Norway Rat***
Synaptomys borealis Richardson **Nothern Bog Lemming**
cooperi Baird **Southern Bog Lemming**

***DIPODIDAE* (JUMPING MICE)**

Napaeozapus insignis Miller **Woodland Jumping Mouse**
Onychomys leucogaster Weid-Neuwied **Northern Grasshopper Mouse**
Perognathus fasciatus Weid-Neuwied **Olive-backed Pocket Mouse**
Zapus hudsonius Zimmermann **Meadow Jumping Mouse**
princeps J.A.Allen **Western Jumping Mouse**

***CASTORIDAE* (BEAVERS)**

Castor canadensis Kuhl **Beaver**

***ERETHIZONTIDAE* (NEW WORLD PORCUPINES)**

Erethizon dorsatum Linnaeus **Porcupine**

***BALAENIDAE* (BOWHEAD WHALES)**

Balaena mysticetus Linneaus **Bowhead Whale** ∞

***MONODONTIDAE* (WHITE WHALE AND NARWHAL)**

Delphinapterus leucas (Pallas) **White Whale or Beluga**

***CANIDAE* (DOGS)**

Alopex lagopus (Linnaeus) **Arctic Fox**
Canis latrans Say **Coyote**
lupus griseoalbus Baird **Gray (Timber) Wolf**
lupus hudsonicus Goldman **Artic Wolf**
lupus lycaon Schreber **Eastern Timber Wolf**
lupus nubilis Say **Plains Wolf†**
Urocyon cinereoargenteus (Schreber) **Grey Fox**
Vulpes velox (Say) **Swift Fox** ∞
vulpes (Linnaeus) **Red Fox**

***URSIDAE* (BEARS)**

Ursus americanus Pallas **Black Bear**
arctos Linnaeus **Grizzly Bear** ∞
maritimus Phipps **Polar Bear**

***PROCYONIDAE* (RACCOONS)**

Procyon lotor (Linnaeus) **Raccoon**

***MUSTELIDAE* (WEASELS)**

Gulo gulo Linnaeus **Wolverine**
Lontra canadensis (Schreber) **River Otter**
Martes americana (Turton) **American Marten**
pennanti (Erxleben) **Fisher**
Mephitis mephitis (Schreber) **Striped Skunk**
Mustela ermnea Linnaeus **Short-tailed Weasel. Ermine. Stoat**
frenata Lichtenstein **Long-tailed Weasel**
nivalis Linnaeus **Least Weasel**
vison Schreber **Mink**
Taxidea taxus (Schreber) **Badger**

***FELIDAE* (CATS)**

Felis concolor Linnaeus **Mountain Lion. Cougar**
Lynx lynx (Linnaeus) **Lynx**
rufus (Schreber) **Bobcat**

***ODOBENIDAE* (WALRUS)**

Odobenus rosmarus (Linnaeus) **Walrus** ∞

***PHOCIDAE* (TRUE SEALS)**

Erignathus barbatus (Erxleben) **Bearded Seal**
Phoca vitulina Linnaeus **Harbour Seal**
groenlandica Erxleben **Harp Seal**
hispida Schreber **Ringed Seal**

***CERVIDAE* (DEER)**

Alces alces (Linnaeus) **Moose**
Cervus elaphus Linnaeus **Elk. Wapiti**
Odocoileus hemionus (Rafinesque) **Mule Deer** ∞
virginianus (Zimmermann) **White-tailed Deer**
Rangifer tarandus caribou (Gmelin) **Woodland Caribou**
tarandus groenlandicus Linnaeus **Barren-ground Caribou**

***ANTILOCAPRIDAE* (PRONGHORNS)**

Antilocapra americana (Ord) **Pronghorn. Antelope** ∞

***BOVIDAE* (ANTELOPES, CATTLE, SHEEP, AND GOATS)**

Bison bison athasbascae Rhoads **Wood Bison** ∞
bison bison (Linnaeus) **Plains Bison** ∞
Ovibos moschatus (Zimmermann) **Musk Ox** ∞

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DID YOU KNOW...?

For a doubling of greenhouse gas concentrations, average temperatures at Norway House could become more like those at Winnipeg, and at Winnipeg more like those at Minneapolis..... **Air**

Zebra mussels are small, brown-and-white striped clam-like animals that pose a serious threat to our fisheries and other water users. Currently found in the Great Lakes, they could spread rapidly into our waters if steps are not taken now..... **Water**

Repap, a leading Canadian pulp and paper company, estimates it will need harvesting rights to 108,000 square kilometres – 33% of Manitoba's productive forest land. But before the company can go ahead with proposed operations, its plans must be approved under The Environment Act, a process that includes public hearings..... **Forests**

In Manitoba, poachers favour pickerel and sturgeon. Birds of prey are also popular, with feathers, eggs, and live birds bringing top prices. Many parts of black bears are taken and sold to meet demand, particularly claws and gall bladders (for aphrodisiacs)..... **Wildlife**

Until recently because of overfishing, much of the famed smoked "Winnipeg goldeye" had to be imported..... **Fish**

In 1989, a pair of peregrine falcons raised a brood of four chicks on the roof of the Delta Winnipeg Hotel – the first confirmed nesting of peregrine falcons in Manitoba in recent years. In 1990, the same pair returned to their "penthouse suite"..... **Special Species**

Bluestem Nature Park on Omands Creek in Winnipeg, built with sod from a construction site near the airport, preserves a patch of native prairie in the midst of the city.... **Special Areas**

Taste and odour problems in domestic water supplies often develop in late summer across the province when blue-green algae are stimulated by a combination of high levels of nutrients, warm water, and long, sunny days..... **Stories From the Files**

Burning straw from a wheat crop can destroy up to $8 per hectare of nitrogen, leaving the field impoverished as well as more costly to fertilize, less resistant to weeds and erosion, and harder to work..... **Agriculture**

In Manitoba, water associated with oil production is so salty that it can damage the soil and is not suitable for watering plants and animals. Producers inject it back into their oil reservoirs to help maintain pressure..... **Energy**

Tailings from gold mines contain residues of cyanide that can harm fish and other aquatic life. Since the cyanide rapidly breaks down into non-toxic products when exposed to sunlight, the danger to the environment can be averted by storing the effluent in a holding pond until oxidation is complete..... **Mining**

The last few years have seen the recycling of asphalt pavements in several highway surfacing projects. Old pavements are broken up and recycled in new ones for major savings in asphalt, aggregates, and other nonrenewable resources..... **Transportation**

"Rurban" development around our cities keeps taking up productive agricultural land and creating pressure for more services and recreational facilities..... **Population**

All proposed projects that could have an impact on the environment must be approved for licensing under The Environment Act. Information on such projects must be on file for people to examine at public registries across the province.... **Legislation**

Project WILD is an environmental and conservation education program designed for youth. Its mission: to help youngsters learn how to think, not what to think..... **Education**

Sustainable development was at work in Manitoba long before the term was coined..... **Sustainable Development**

Manitobans generate nearly 1,000,000 tonnes of garbage every year – about a tonne of waste for every person in the province..... **Waste Management**